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DANGEROUS PROPERTIES
of
INDUSTRIAL MATERIALS

A Completely Revised and Enlarged Edition of

HANDBOOK OF DANGEROUS MATERIALS

by

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PREFACE

The purpose of this book is to extend the scope of and improve upon the usefulness of a previous work in this field, entitled "Handbook of Dangerous Materials." Its objective is to afford readers a more detailed picture of the hazards which accompany the use of the materials of industry, and also to supply authentic textual material by means of which the reader can gain insight into the reasons for doing as suggested in the General Chemical Section (Section 10), as well as background enough to solve on-the-spot safety problems that arise in day-to-day industrial operations.

In order to achieve these aims the following things have been done:

(1) The usefulness of the General Chemical Section has been profoundly improved by increasing the number of entries from 5500 to nearly 9000; by listing under the appropriate elements the commonly used radioisotopes and the nuclear properties of each, as well as the hazard potential of many of them, as taken from NBS Handbook 42 and NBS Handbook 52; by listing detailed toxic hazard ratings for the thousands of materials for which adequate and reliable data are available; by discussing in detail the toxicology of hundreds of industrially significant materials and classes of materials in common use; by listing the fire, explosion and disaster hazard potential of all the materials about which data could be obtained; by keying thousands of materials back to pertinent text sections on industrial hygiene and ventilation; by referencing many materials of allergenic significance back to a text section on allergic disease in industry; and finally by cross-referencing highly hazardous materials to textual discussions of toxicology, fire hazard and storage problems.

(2) Our response to the impact of nuclear technology upon industry is evidenced by an entirely new section on reactor safeguards as well as an expanded section of text on radiation hazards in industry.

(3) For the industrial physician we include a section on industrial toxicology and one on allergic disease in industry.

(4) For the industrial hygienist and safety man, sections on the control of industrial hazards, personnel protection and air pollution as well as sections on fire and explosion hazards and the storage and handling of dangerous materials.

(5) For those who ship, receive or transport possibly dangerous materials, an up-to-date section on I.C.C. shipping regulations exclusive of container specifications is included. This will be of interest also to warehousemen and traffic managers. These regulations are keyed to those entries of Section 10 which are regulated by I.C.C. Any Coast Guard regulated materials are so noted, and where the Manufacturing Chemists Association suggests a label, it is so noted.

In order to fit all this material into one book of reasonable size, it has been necessary to forego repetitive explanations and sterotyped instructions, warnings or reasons for a given recommendation. As a result, a vast number of cross-references were required; these have been used with care and should not be overlooked by the user of the book, as they are essential in obtaining a complete picture of a given material.

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SECTION 1

TOXICOLOGY

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This section has been prepared for the purpose of providing a certain amount of background for those who may be called upon to understand and interpret data which are largely medical in nature, rather than for physicians or others who have been specially trained in the field of industrial toxicology.

Toxicity Defined

Toxicity is the ability of a chemical molecule or compound to produce injury once it reaches a susceptible site in or on the body. Toxicity hazard is the probability that injury may be caused by the manner in which the substance is used.

Acute. This term will be used in the medical sense to mean "of short duration." As applied to materials which are inhaled or absorbed through the skin, it refers to a single exposure of a duration measured in seconds, minutes or hours. As applied to materials which are ingested, it refers generally to a single quantity or dose.

Chronic. This term will be used in contrast to "acute" and means "of long duration." As applied to materials which are inhaled or absorbed through the skin, it refers to prolonged or repeated exposures of a duration measured in days, months or years. As applied to materials which are ingested, it refers to repeated doses over a period of days, months or years. The term "chronic" will not refer to severity of symptoms but will carry the implication of exposures or doses which would be relatively harmless unless extended or repeated over long periods of time (days, months or years). In this book the term "chronic" includes exposures which might also be called "subacute," i.e., somewhere between "acute" and "chronic."

Local. This term refers to the site of action of an agent and means that the action takes place at the point or area of contact. The site may be skin, mucous membranes of the eyes, nose, mouth, throat, or anywhere along the respiratory or gastrointestinal system. Absorption does not necessarily occur.

Systemic. This term refers to a site of action other than the point of contact and presupposes that absorption has taken place. It is possible, however, for toxic agents to be absorbed through a channel (skin, lungs or intestinal canal) and produce later manifestations on one of those channels which are not a result of the original direct contact. Thus it is possible for some agents to produce harmful effects on a single organ or tissue as a result of both "local" and "systemic" actions.

Absorption. A material is said to have been absorbed only when it has gained entry into the blood stream and consequently may be carried to all parts of the body. Absorption requires that a substance pass through the skin, a mucous membrane, or the air sacs (alveoli) of the lungs.

Toxicity Ratings

An explanation of the toxicity ratings is given in the following paragraphs:

U = Unknown. This designation is given to substances which fall into one of the following categories:

(a) No toxicity information could be found in the literature and none was known to the authors.
(b) Limited information based on animal experiments was available but in the opinion of the authors this information could not be applied to human exposures.
(c) Published toxicity data were felt by the authors to be of questionable validity.

0 = No toxicity. This designation is given to materials which fall into one of the following categories:
(a) Materials which cause no harm under any conditions of use.
(b) Materials which produce toxic effects on humans only under the most unusual conditions or by overwhelming dosage.

1 = Slight toxicity
(a) Acute Local. Materials which on single exposures lasting seconds, minutes or hours cause only slight effects on the skin or mucous membranes regardless of the extent of the exposure.
(b) Acute Systemic. Materials which can be absorbed into the body by inhalation, ingestion or through the skin and which produce only slight effects following single exposures lasting seconds, minutes, or hours, or following ingestion of a single dose, regardless of the quantity absorbed or the extent of exposure.
(c) Chronic Local. Materials which on continuous or repeated exposures extending over periods of days, months or years cause only slight harm to the skin or mucous membranes. The extent of exposure may be great or small.
(d) Chronic Systemic. Materials which can be absorbed into the body by inhalation, ingestion or through the skin and which produce only slight effects following continuous or repeated exposures extending over days, months or years. The extent of the exposure may be great or small.

In general, those substances classified as having "slight toxicity" produce changes in the human body which are readily reversible and which will disappear following termination of exposure, either with or without medical treatment.

2 = Moderate toxicity.
(a) Acute Local. Materials which on single exposure lasting seconds, minutes or hours cause moderate effects on the skin or mucous membranes. These effects may be the result of intense exposure for a matter of seconds or moderate exposure for a matter of hours.
(b) Acute Systemic. Materials which can be absorbed into the body by inhalation, ingestion or through the skin and which produce moderate effects following single exposures lasting seconds, minutes or hours, or following ingestion of a single dose.
(c) Chronic Local. Materials which on continuous or repeated exposures extending over periods of days, months or years cause moderate harm to the skin or mucous membranes.
(d) Chronic Systemic. Materials which can be absorbed into the body by inhalation, ingestion or through the skin and which produce moderate effects following continuous or repeated exposures extending over periods of days, months or years.

Those substances classified as having "moderate toxicity" may produce irreversible as well as reversible changes in the human body. These changes are not of such severity as to threaten life or produce serious permanent physical impairment.

3 = Severe toxicity.
(a) Acute Local. Materials which on single exposures lasting seconds or minutes cause injury to skin or mucous membranes of sufficient severity to threaten life or to cause permanent physical impairment or disfigurement.
(b) Acute Systemic. Materials which can be absorbed into the body by inhalation, ingestion or through the skin and which

can cause injury of sufficient severity to threaten life following a single exposure lasting seconds, minutes or hours, or following ingestion of a single dose.

(c) Chronic Local. Materials which on continuous or repeated exposures extending over periods of days, months or years can cause injury to skin or mucous membranes of sufficient severity to threaten life or to cause permanent impairment, disfigurement or other irreversible change.

(d) Chronic Systemic. Materials which can be absorbed into the body by inhalation, ingestion or through the skin and which can cause death or serious physical impairment following continuous or repeated exposures to small amounts extending over periods of days, months or years.

Toxicology Defined

In simple terms, toxicology may be defined as the study of the action of poisons on the living organism. Industrial toxicology is concerned with the human organism and consequently lies within the broad field of medicine. Since medicine cannot be considered an exact science in the same sense as chemistry, physics or mathematics, *toxicologic phenomena cannot always be predicted with accuracy or explained on the basis of physical or chemical laws.* It is this unpredictability which frequently reduces conclusions and decisions to opinion rather than fact.

Poison Defined

In attempting to define the term "poison," a major consideration is that of *quantity* or *dosage*. A poison may be defined as a substance which causes harm to living tissues when applied in relatively small doses. It is not always easy to make a clear-cut distinction between poisonous and nonpoisonous substances. (See further discussion on p. 4).

Effective Dosage

Generally speaking, industrial toxicology is concerned with the effects of substances which gain entry into some part of the human body. Almost any substance can cause harm when applied directly to the skin. Among the factors which are concerned in effective dosage, the most important are:

(1) Quantity or concentration of the material.
(2) Duration of exposure.
(3) State of dispersion (size of particle or physical state, e.g., dust, fume, gas, etc.).
(4) Affinity for human tissue.
(5) Solubility in human tissue fluids.
(6) Sensitivity of human tissues or organs.

Obviously there are possibilities for wide variations in any of these factors.

Methods of Expressing Effective Dosage:

(1) Maximum Allowable Concentration (MAC).

For gases and vapors the MAC value is usually expressed in parts per million (ppm), that is, parts of the gas or vapor per million parts of air.

For fumes and mists, and for some dusts, the MAC is usually given as milligrams per cubic meter (mgm/m^3) or per 10 cubic meters of air.

For some dusts, particularly those containing silica, the MAC is usually expressed as millions of particles per cubic foot of air MPPCF.

MAC values have gained wide acceptance in industrial toxicology as a means of expressing concentrations of potentially harmful substances. They purport to represent the greatest amount of a substance to which persons may be exposed for 8 hours a day for a period of months or years without danger to health.

Literal acceptance of this concept is dangerous for the following reasons:

(a) A great majority of all published MAC values are based either on speculation, opinion or limited experimentation on rats, mice, guinea pigs or other laboratory animals. In very few instances have the values been established firmly on a basis of examinations of human subjects correlated with adequate environmental observations.

(b) Concentrations of toxic or harmful materials in any working environment rarely remain constant throughout a work day. The occurence of "surges" is well known.

(c) Industrial exposures frequently involve mixtures rather than single compounds. Very little is known about the effects of mixtures.

(d) Individuals vary tremendously in their sensitivity or susceptibility to toxic substances. The factors controlling this variability are not well understood. It should not be assumed that conditions which are safe for some individuals will be safe for all.

(e) For some substances, concentrations which may be considered "safe" may still result in discomfort or annoyance.

(f) A single MAC value is usually given for substances which occur in the form of salts or compounds of different solubility or in different physical states (e.g., lead, mercury).

If the above limitations are understood and accepted, the published MAC values can be used to great practical advantage. Their principal usefulness is in connection with the design of ventilating systems (see Section 2). Ventilation engineers must have a concrete figure to serve as the basis for the design of ventilating equipment. It should not be assumed, however, that attainment of concentrations at or even below the published MAC limits will necessarily prevent all cases of occupational poisoning; nor should it be assumed that concentrations which exceed the given limits will necessarily result in cases of poisoning. The concept known as Haber's Law, which involves the product of concentration and time (C x T = K), expresses an index of the degree of toxic effect. This too, may be misleading, since little is known of the relative effectiveness of large doses over a short period of time as compared with smaller doses over a longer time period.

(2) Minimal Lethal Dose and LD50 Test.

In experimental toxicology it is common practice to determine the quantity of poison per unit of body weight of an experimental animal which will have a fatal effect. (A scale commonly used is milligrams of poison per kilogram of body weight.) That amount per unit of body weight which will cause even one fatality in a group of experimental animals is known as the minimal lethal dose (MLD). A more commonly used figure in experimental industrial toxicology is the amount which will kill one-half of a group of experimental animals. This is known as the LD50 test (Lethal Dose 50 per cent) representing 50 per cent fatalities.

The Manufacturing Chemists Association bases its definition of the term "poison" on this test. In its publication entitled "Warning Labels" (4th edition) it states the following: "Poison: A chemical or mixture of chemicals which falls within any of the following categories:

(a) Produces death within 48 hours in half or more than half of a group of 10 or more laboratory white rats weighing 200-300 grams at a single dose of 50 milligrams or less per kilogram of body weight, when administered orally; or

(b) Produces death within 48 hours in half or more than half of a group of 10 or more laboratory white rats weighing 200-300 grams, when inhaled continuously for a period of one hour or less at an atmospheric concentration of 2 milligrams or less per liter of gas, vapor, mist, or dust, provided such concentration is likely to be encountered by man when the chemical product is used in any reasonable foreseeable manner; or

(c) Produces death within 48 hours in half or more than half of a group of 10 or more rabbits tested in a dosage of 200 milligrams or less per kilogram body weight, when administered by continuous contact with the bare skin for 24 hours or less.

"If available data on human experience with any chemical in the above-named concentrations indicate results different from those obtained on animals, the human data shall take precedence in determining whether the product falls within the definition of poison."

(3) "Range Finding" Test. This approach to determining and expressing the degree of toxicity of chemicals used in industry has been developed primarily by H. F. Smyth, Jr., and his collaborators. Its greatest usefulness is in testing new compounds for which no toxicological information exists. The basis of the test is a comparison of the potency of an unknown compound with that of a more familiar material. This is possible since there are a number of chemicals for which fairly extensive toxicological data are already available. By this technique a certain amount of valuable information can be obtained within a space of about three weeks.

(4) Hazard Rating. This term is used in this book to indicate whether a material has high, moderate, or slight toxicity hazard, or none at all. It is obviously a somewhat crude method but it will serve as a rough guide to the risk involved in exposure to various chemicals until further information can be obtained.

The hazard ratings of industrial chemicals are based on an interpretation of all available information, particularly MAC, LD50, and Range Finding data.

Toxicity by Analogy

Because of the paucity of toxicological information on many chemical compounds used in industry there frequently is a tendency to assume that compounds which are closely related chemically will have similar toxic properties. While this may be true for a limited number of substances it is by no means universally true.

As mentioned elsewhere, many chemical compounds, when absorbed by the body, undergo a series of changes (detoxication processes) before they are excreted. The intermediary products depend largely on the chemical structure of the original material, and minor differences in structure may result in totally different intermediary and end products. This principle is well illustrated in the case of benzene and toluene, which are closely related chemically but whose metabolism is dissimilar. The degree of toxicity of the two is also very different. "Toxicity by analogy" can be very dangerous and misleading.

Classes of Toxic Substances

Toxic or harmful substances encountered in industry may be classified in various ways. A simple and useful classification is given below, together with definitions adopted by the American Standards Association.

Dusts. Solid particles generated by handling, crushing, grinding, rapid impact, detonation and decrepitation of organic or inorganic materials such as rocks, ore, metal, coal, wood, grain, etc. Dusts do not tend to flocculate except under electrostatic forces; they do not diffuse in air, but settle under the influence of gravity.

Fumes. Solid particles generated by condensation from the gaseous state, generally after volatilization from molten metals, etc., and often accompanied by a chemical reaction such as oxidation. Fumes flocculate and sometimes coalesce.

Mists. Suspended liquid droplets generated by condensation from the gaseous to the liquid state or by breaking up a liquid into a dispersed state, such as by splashing, foaming, and atomizing.

Vapors. The gaseous form of substances which are normally in the solid or liquid state and which can be changed to these states either by increasing the pressure or decreasing the temperature alone. Vapors diffuse.

Gases. Normally formless fluids which occupy the space of enclosure and which can be changed to the liquid or solid state only by the combined effect of increased pressure and decreased temperature. Gases diffuse.

This classification does not include the obvious categories of solids and liquids which may be harmful nor does it encompass physical agents. The latter, strictly speaking, cannot be considered "substances." Living agents, such as bacteria, molds, and other parasites comprise another group of "substances" that would appear in a comprehensive classification of industrial health hazards.

Routes of Absorption

In the physiologic sense, a material is said to have been absorbed only when it has gained entry into the blood stream and consequently is carried to all parts of the body. Something which is swallowed and which is later excreted more or less unchanged in the feces has not necessarily been absorbed, even though it may have remained within the gastrointestinal tract for hours or even days. The industrial toxicologist is concerned primarily with three routes of absorption or portals of entry through which materials may enter the blood stream: the skin, the gastrointestinal tract, and the lungs.

Absorption Through the Skin. Before the introduction of modern methods in the treatment of syphilis, a part of the standard therapy consisted of mercury treatment. Its effectiveness depended on the fact that certain forms of mercury can be absorbed through the intact skin. It is now recognized that skin absorption may be a significant factor in occupational mercury poisoning as well as in a number of other industrial diseases. In the case of metals other than mercury, however, entry through the skin is relatively unimportant except for some organometallic compounds such as lead tetraethyl.

Skin absorption attains its greatest importance in connection with the organic solvents. It is generally recognized that significant quantities of these compounds may enter the body through the skin either as a result of direct accidental contamination or indirectly when the material has been spilled on the clothing. An additional source of exposure is found in the fairly common practice of using industrial solvents for removing grease and dirt from the hands and arms, in other words, for washing purposes. This procedure, incidentally, is a fruitful source of dermatitis.

Gastrointestinal Absorption. The mere fact that something has been taken into the mouth and swallowed does not necessarily mean that it will be absorbed. Naturally, the less soluble the material is, the less is the likelihood of absorption. In the past it has been common practice to attribute certain cases of occupational poisoning to uncleanly habits on the part of the victim, particularly failure to wash the hands before eating. There is no doubt that some toxic materials used industrially can be absorbed through the intestinal tract but it is now generally believed that with certain notable exceptions this portal of entry is of minor importance. One outstanding exception is the case of the radium dial painters who followed the practice of "pointing" their brushes between their lips, thus ingesting lethal quantities of radioactive material. Accidental swallowing of harmful amounts of poisonous compounds in single large doses has also been known to occur. In general it can be said that intestinal absorption of industrial poisons is of minor importance and that the "dirty hands" theory of poisoning has been pretty well discredited.

Absorption Through the Lungs. The inhalation of contaminated air is by far the most important means by which occupational poisons gain entry into the body. It seems safe to estimate that at least 90 per cent of all industrial poisoning (exclusive of dermatitis) can be attributed to absorption through the lungs. Harmful substances may be suspended in the air in the form of dust, fume, mist or vapor, and may be mixed with the respired air in the case of true gases. Since an individual under conditions of moderate exertion will breathe about 10 cubic meters of air in the course of an ordinary 8-hour working day it is readily understood that any poisonous material present in the respired air offers a serious threat.

Fortunately all foreign matter which is inhaled is not necessarily absorbed into the blood. A certain amount, particularly that which is in a very finely divided state, will be immediately exhaled. Another portion of respired particulate matter is trapped by the mucus which lines the air passages and is subsequently brought up in the sputum. (In this connection it might be mentioned that some of the sputum may be consciously or unconsciously swallowed, thus affording an opportunity for intestinal absorption.) Other particles are taken up by "scavenger cells" following which they may enter the blood stream or be deposited in various tissues or organs. True gases will pass directly from the lungs into the blood in the same manner as the oxygen in inspired air. Because of the fact that a great majority of the known industrial poisons may at some time be present as atmospheric contaminants and thus constitute a potential threat to health, programs directed toward the prevention of occupational poisoning generally place major emphasis on some form of ventilation to reduce the hazard (see Section 2).

Individual Susceptibility

The term "individual susceptibility" has long been used to express the well-known fact that under conditions of like exposure to potentially harmful substances there is usually a marked variability in the manner in which individuals will respond. Some may show no evidence of intoxication whatsoever; others may show signs of mild poisoning, while still others may become severely or even fatally poisoned. Comparatively little is known about the factors which are responsible for this variability. It is believed that differences in the anatomical structure of the nose may be concerned with different degrees of efficiency in filtering out harmful dusts in the inspired air. Previous infections of the lungs, particularly tuberculosis, are known to enhance susceptibility to silicosis. Most industrial toxicologists believe that obesity is an important predisposing factor among persons who are subject to occupational exposure to organic solvents and related compounds. Age and sex are also believed to play a part and previous illnesses may be significant.

Other possible factors relating to individual susceptibility are even less well understood than those just mentioned. It has been suggested that different rates of working speed, resulting in variations in respiratory rate, in depth of respiration and in pulse rate may play a part. The action of the cilia, those tiny hairs present in the cells which line the air passages, may have some importance. The permeability of the lungs may influence absorption and the efficiency of the kidneys may govern the rate at which toxic materials are excreted, but the underlying nature of these possible variations is not known.

There is considerable literature purporting to show that nutritional factors may have something to do with susceptibility to occupational poisoning. Most of the published material is rather unscientific and unconvincing but a few reports recently published strongly suggest that there actually exists a relationship between the nature of the diet and susceptibility to poisoning. There is as yet no substantial evidence that the addition of vitamin concentrates or special foods have any protective value, but when diets are deficient in some of the essential nutritional elements it appears that poisoning is more likely to occur. There is considerable evidence that indulgence in ethyl alcohol will significantly increase the possibility of occupational poisoning occurring, particularly from organic solvents.

Acute and Chronic Effects

Industrial toxicology is generally concerned with the effects of low-grade sub-lethal exposures which are continued over a period of months or years. It is, of course, true that toxicological problems are not infrequently presented as a result of accidents which create sudden massive exposures to overwhelming concentrations of toxic compounds. The acute poisoning which results may cause unconsciousness, shock or collapse, severe inflammation of the lungs or even sudden death. An understanding of the nature of the action of the offending agent may be of great value in the treatment of acute poisoning but in some instances the only application of toxicological knowledge will be in establishing the cause of death.

The detection of minute amounts of toxic agents in the atmosphere and in body fluids (blood and urine) and the recognition of the effects of exposure to small quantities of poisons are among the principal jobs of the industrial toxicologist. The manifestations of chronic poisoning are often so subtle that the keenest judgment is required in order to detect and interpret them. The most refined techniques of analytical chemistry and of clinical pathology are called into play, involving studies of the working environment and of exposed individuals.

In order to demonstrate that chronic industrial poisoning has taken place or is a possibility it must be shown that an offending agent is present in significant concentrations, that it has been absorbed, and that it has produced disturbances in the exposed subject. Significant concentrations are ordinarily expressed in terms of maximum allowable concentrations. Absorption of a substance may be proved by demonstrating its presence in the blood or urine in concentrations above those found in non-exposed persons, or by finding certain metabolic products in the excreta. To prove that disturbances have occurred in an exposed subject may require the application of all the diagnostic procedures used in medicine, including a medical history, physical examination, blood counts, urinalysis, x-ray studies and other measures.

A few of the more widely used industrial chemicals, notably lead and benzene, will produce changes in the blood in the very early stages of poisoning. Other chemicals, particularly chlorinated hydrocarbons, give no such early evidence of their action. Heavy metals such as mercury and lead produce their chronic harmful effects through what is known as "cumulative action." This means that over a period of time the material which is absorbed is only partially excreted and that increasing amounts accumulate in the body. Eventually the quantity becomes great enough to cause physiologic disturbances. Volatile compounds do not accumulate in the body but probably produce their chronic toxic effects by causing a series of small insults to one or more of the vital organs.

Site of Action of Poisons

Brief mention has already been made of the fact that different poisons act on different parts of the body. Many substances can produce a local or direct action upon the skin. The fumes and mists arising from strong acids, some of the war gases and many other chemicals have a direct irritating effect on the eyes, nose, throat and lower air passages. If they reach the lungs they may set up a severe inflammatory reaction called chemical pneumonitis. These local effects are of greatest importance in connection with acute poisoning. More important to the industrial toxicologist are the so-called systemic effects.

Systemic or indirect effects occur when a toxic substance has been absorbed into the blood stream and distributed throughout the body. Some materials such as arsenic, when absorbed in toxic amounts, may cause disturbances in several parts of the body: blood, nervous system, liver, kidneys and skin. Benzene, on the other hand, appears to affect only one organ, namely, the blood-forming bone marrow. Carbon monoxide causes asphyxia by preventing the hemoglobin of the blood from carrying out its normal function of transporting oxygen from the lungs to the tissues of the body. Although oxygen starvation occurs equally in all parts of the body, brain tissue is most sensitive; consequently the earliest manifestations are those due to damage to the brain. An understanding of what organ or organs can be damaged, and the nature and manifestations of the damage caused by various compounds, is among the more important functions of the industrial toxicologist.

Absorption and Poisoning

As mentioned above, with the exception of external irritants, toxic substances generally must be absorbed into the body and distributed through the body by means of the blood stream in order for poisoning to occur. In other words, poisoning ordinarily does not occur without absorption. On the other hand, absorption does not necessarily or always result in poisoning. The human body is provided with an elaborate system of protective mechanisms and is able to tolerate to an amazing degree the presence of many toxic materials. Some foreign materials are excreted unchanged through the urine and feces. Toxic gases, following absorption, may be given off through the lungs. Some chemical compounds go through processes of metabolism and are excreted in an altered form. Some of these processes are known as detoxication (or detoxification) mechanisms. In some instances the intermediary products in a detoxication process may be more toxic than the original substance, e.g., formic acid and formaldehyde from methyl alcohol.

Since absorption must precede poisoning, the question often arises as to where the dividing line between absorption and poisoning is to be drawn. An answer to this question frequently entails considerable difficulty. There is no doubt that when absorption reaches a point where it causes impairment of health, poisoning has occured. Impaired health manifests itself by the presence of altered structure, altered function, or a combination of the two. These impairments, in turn, result in abnormal symptoms, abnormal physical or laboratory findings, or combinations of these.

When absorption has produced both abnormal symptoms and abnormal objective findings there is no question that poisoning has occurred. In the opinion of the writer, absorption which produces objective evidence of altered structure or function should also be called poisoning, even though there may be no abnormal subjective symptoms. When subjective symptoms constitute the only basis for distinguishing between absorption and poisoning, the distinction becomes a matter of medical opinion requiring individual evaluation.

Causal Relationship and Competent-Producing Cause

The industrial toxicologist frequently becomes involved in medico-legal problems since actual or suspected cases of occupational disease often result in workmen's compensation claims or negligence suits. A successful legal action on the part of a claimant or plaintiff depends upon his ability to demonstrate, usually through medical or other expert testimony, that occupational exposure harmed his health.

A competent producing cause is one which conceivably *could* have produced the harmful effect. It involves possibility.

Causal relationship exists when a competent producing cause actually *did* produce the harmful effect. It involves probability.

Medico-legal cases are usually adjudicated on the basis of opinion because of the fact that medicine is not an exact science. It has been said, and truthfully, that in medicine anything can happen. Decisions, then, must be made on the basis of the most probable explanation of a set of circumstances. Medical opinion, to be convincing, must be based on actual facts or observations, but the same set of facts or observations may be subject to more than one interpretation. Hence the importance of opinion.

Workmen's compensation laws are usually written or interpreted in such a way that in cases of doubt (sometimes reasonable doubt) a decision is rendered in favor of the claimant. Socially this is probably correct, at least in theory. This practice, however, tends to place the burden of proof on the defendant rather than on the claimant. Competent producing cause is all too often considered to be synonymous with causal relationship. Often it devolves upon a defendant to attempt to prove that a competent producing cause was in fact not the actual cause of an illness. Obviously this may entail considerable difficulty. It is not sufficient for the defendant merely to deny the existence of causal relationship. Successful defense requires an opinion (diagnosis) other than that of an occupational disease which will provide a more convincing explanation of the observed facts. Often this requires the highest degree of diagnostic acumen as well as the most astute legal procedure.

Principles of Prevention

Any effective program for the prevention of occupational poisoning depends on teamwork. Key members of the preventive team are the industrial physician with his knowledge of toxicology, the industrial hygiene engineer with his understanding of control measures, and the chemist who provides basic analytical data. The industrial nurse, because of her intimate contact with employed personnel, often provides the first clue to the existence of a potentially dangerous situation. Safety men and supervisors also play an important part, while a well-informed working force, instructed to recognize danger signs, constitutes an additional safeguard.

It was pointed out above that an understanding of the basic principles of industrial toxicology is fundamental in any program of prevention. One must know what materials cause poisoning and the relative toxicity of various compounds and groups of compounds. Another essential is an understanding of how toxic substances are absorbed, and the relative importance of the various routes of absorption. Realization of the fact that inhalation is the principal mode of entry means that preventive measures will be directed mainly toward reducing atmospheric contamination. For protection against chemicals that can be absorbed through the skin, suitable impervious gloves and work clothing can be provided.

Although very little is known about "individual susceptibility," the few facts which are available may be helpful in selectively placing certain persons in jobs where their age, sex, state of nutrition or previous illnesses will not constitute any extra threat to their well-being. Thorough familiarity with the so-called maximum allowable concentrations, their interpretation and applications is essential for the engineer who is called upon to design ventilation systems. All who are concerned with a preventive program must know that months or years of exposure may elapse before toxic manifestations appear, and the physician in particular must be prepared to detect and recognize the earliest evidences of poisoning. Failure to apply these few fundamentals may be costly not only in terms of lost production and lost income but also in terms of health and even of life.

Preventive procedures are often spoken of as falling into two major categories: (1) medical control and (2) engineering control.

(1) *Medical Control.* This term is used to describe those procedures which are applied to the employed person. It includes:

(a) Preplacement physical examinations. One purpose of these examinations is to protect workers with known susceptibility against any potentially harmful exposure. An individual found to have healed pulmonary tuberculosis, for example, should not be placed in a job entailing exposure to silica dust nor should one with a former liver disease be exposed to chlorinated hydrocarbons.

(b) Periodic examinations. A major purpose of these is to detect any existing evidence of poisoning at an early stage when corrective measures can be expected to result in complete recovery. Correction may call for improved industrial hygiene practices, for temporary or permanent change of job assignment, or both of these.

(c) Education. The purpose of this is to inform workers and supervisory personnel of the nature of any potentially harmful materials with which they may come in contact. An informed working force may be expected to accept and observe recommended precautionary measures.

(d) Personal protective devices. With few exceptions, personal protective devices should be relied upon only when the application of engineering measures offers insurmountable difficulties. Protective clothing is usually worn to prevent injuries and so will not be discussed here.

Protective masks have been widely used, or rather misused, to reduce the inhalation of potentially harmful dusts, fumes, vapors, mists and gases. In general it can be said that reliance on masks is justified only when exposures are of short duration (minutes) and low frequency (10 - 20 times daily).

Protective masks or respirators obviously should be properly selected for the purpose for which they are intended. To be effective they must be individually fitted to the user. In the filter or canister types the filtering units must be replaced regularly and with adequate frequency. A program of regular cleaning, repairing and replacing of worn out parts is highly desirable. Those who are obliged to wear respirators or masks should be fully instructed as to proper use and maintenance. Unless these rules are followed it cannot be said that masks and respirators are being properly used and it might be preferable not to use them at all. See Section 3.

(2) *Engineering Control.* (See also Section 2.) In this category are included those procedures which are applied to the working environment rather than to the individual. The most important engineering control measures are:

(a) Substitution of a less toxic in place of a more toxic material, when this is possible technologically. Common examples of this approach are the use of certain ketones in place of benzene and the use of steel shot in place of silica sand in sand-blasting.

(b) Enclosure of a process. This has its widest application in the chemical industries where frequently it is possible and practicable to design totally enclosed systems for carrying out the manufacture or processing of chemical compounds.

(c) Segregation. This may be accomplished by confining a potentially dangerous process to a segregated or enclosed area to prevent contamination of adjacent work spaces. In some situations segregation can be accomplished by locating a process in an open shed or even completely out of doors.

(d) Ventilation. This is perhaps the most important engineering control measure. Ventilation may be general or local. General ventilation consists in rapid dilution of contaminated air with fresh air usually by fans located in windows or overhead in work areas. Fans or blowers may operate by bringing fresh air into a space, thus forcing contaminated air out through natural openings such as doors and windows, or by drawing off contaminated air thus creating a partial vacuum which is filled by the entry of fresh air. Unpleasant drafts of air, particularly near open doors and windows, are sometimes caused when natural ventilation is produced in large volume.

Local ventilation usually consists in providing air suction close to the point where potentially harmful dusts, fumes, vapors, mists or gases are generated. This permits removal of the contaminants with relatively small quantities of air and prevents contamination of adjacent work spaces. Collection and disposal of contaminants removed by local exhaust ventilation sometimes presents a major engineering problem. In some processes, especially those involving the use of volatile chemicals, it is common practice to install a recovery system as part of the ventilating equipment. This may result in savings sufficient to defray the cost of installing and operating the ventilating system.

(e) Wetting. The use of water to limit the dispersal of atmospheric contaminants finds its chief application in the control of dust. This procedure is widely used in rock-drilling and it is also useful when sweeping is done in a dusty work-room.

(f) Neutralization or inactivation of chemical compounds is sometimes useful in connection with local exhaust ventilation and in cleaning up contaminated areas.

(g) General housekeeping procedures, while perhaps the simplest of all control measures, are none-the-less extremely important and valuable. Regular clean-up schedules, particularly where dust is a problem, are essential in any control program.

In addition to the specific procedures just enumerated, it is often important to conduct regular appraisals of the working environment by means of dust counts, air analyses and similar tests, thereby checking on the effectiveness of the preventive measures.

FIRST AID

Emergency Treatment of Acute Poisoning

Acute poisoning may be the result of entry into the body of large or concentrated doses of a poison through

(a) Breathing (inhalation)
(b) Swallowing (ingestion)
(c) Skin absorption
(d) Injection (hypodermic or intravenous entry).

It is obvious that the route of entry will influence the type of emergency treatment.

In every case of acute poisoning, summon medical assistance immediately. The names and telephone numbers of one or more on-call physicians, the nearest hospital and ambulance service should be posted near appropriate telephones.

If the police department, fire department or utility company maintains an emergency service, their telephone numbers should also be posted.

Every industrial establishment, no matter how small, should have at least one person on duty at all times who is trained and designated to take charge in the event of an emergency due to poisoning. This individual should be conversant with the emergency handling of the particular situations that may arise.

Improper first aid may be more harmful than none at all.

Although prompt action is always important, there are relatively few situations in which a delay of seconds or minutes will have a significant bearing on the outcome.

When possible, a sample of the suspected poison, or the container from which it came, should be preserved for the guidance of the treating physician, the police or the medical examiner (coroner).

General Procedures

(A) Inhalation:

(1) Remove victim from contaminated area. Rescuers should be properly protected or provided with life lines.

(2) Keep victim warm (not hot) and quiet. Lying flat is usually the best position.

(3) If breathing has stopped, give artificial respiration.

(4) Administer oxygen, if it is available.

(5) Keep breathing passages open. Examine mouth for false teeth and chewing gum and remove them if present.

(B) Ingestion:

(1) Attempt to empty the stomach by causing vomiting or use of an emetic. This should be done even if a period of several hours has passed since the poison was swallowed. Exceptions. Corrosive chemicals such as strong acids or caustic alkalies, victim having convulsions, victim unconscious.

(2) Dilute the poison by administering fluids in any of the following forms:

(a) Plain tap water: 3-4 glasses.
(b) Soapy water: 2-3 glasses.
(c) Table salt in warm water: 1 tablespoon to an ordinary 8 ounce tumbler.
(d) Milk: 3-4 glasses.

If these fluids are vomited, which is desirable, the doses may be repeated several times.

(3) Give the victim a "universal antidote." A mixture of powdered burnt toast (charcoal), strong tea and milk of magnesia will absorb and neutralize many poisons. (One piece of toast and 4 tablespoons of milk of magnesia in a cup of strong tea).

(C) Skin Contact:

(1) Dilute the contaminating substance with large amounts of water. This is best done in a shower, but may also be done with a hose, buckets or

other means. The water should be lukewarm if possible.

(2) Remove contaminated clothing. Those assisting the victim should protect their own skin with gloves, if available

(3) Chemical burns of the eye should be treated with large amounts of water or with a weak solution of bicarbonate of soda(a level teaspoonful of bicarbonate to 1 quart of warm, clean water).

(D) Injected Poisons:

(1) Absorption may be delayed by the application of a tourniquet above the point of injection if this is in the arm or leg. The tourniquet should not be so tight that it impairs the flow of arterial blood.

(2) Excretion can be hastened by administering large doses of water or other fluid.

(3) Attempt to determine the nature of the poison so that the proper antidote can be given.

LABORATORY PROCEDURE

Application and Interpretation

It is axiomatic that accurate diagnosis is basic to the proper handling of any medical problem. Diagnosis is rarely, if ever, established by any single observation or test. A total picture, as determined through the history, the physical examination and diagnostic tests, must be obtained and interpreted. Frequently there is a tendency on the part of persons who have not had medical training to place undue emphasis on the importance of laboratory procedures. This is understandable since deviations from the normal which can be expressed in terms of numbers may be more comprehensible than data obtained by the taking of a history or performing a physical examination. The important point is that ordinarily a reliable diagnosis can be arrived at only by securing and interpreting all available information

Laboratory procedures in industrial toxicology can be divided into two major classes: (1) those applied to human beings and (2) those applied to the environment. The present discussion is concerned only with the former.

Basic Principles:

(1) *Specificity of Laboratory Tests.* The human organism is limited in the manner in which it can react to harmful influences from outside or morbid processes originating within the body. In other words, *similar or identical changes may be produced by widely differing causes.* A familiar example of this is the presence of stippled red blood cells which can be found in lead poisoning but which also occur in a number of blood disorders such as anemias and leukemias. There are few, if any, laboratory tests which can be said to be pathognomonic, that is, so selective and specific that a positive result in and of itself alone is sufficient to determine a diagnosis.

(2) *Normal Values.* Those who have been trained in the physical sciences are accustomed to think of physical constants in terms of fixed or absolute values. Such things as freezing and melting point, vapor pressure and many other characteristics of materials have a single fixed value when measured under the same conditions. The situation in the biological sciences is not so simple. It can be stated categorically that *in the quantitative study of biological materials (blood, urine, etc.) there is no such thing as a single, fixed normal value.* There is, however, a normal *range*. Failure to understand this principle has been responsible for many erroneous conclusions. Unless one knows what is normal, it is impossible to know what is abnormal.

(3) *Trends and Mass Data.* Very often a single, isolated laboratory test will be inconclusive as to whether it indicates a normal or abnormal state. Serial observations made over a period of time and showing a trend in a certain direction may be highly significant even though none of the individual tests yields results falling outside the normal range. For example, a series of blood counts starting in the upper part of the normal range and gradually but steadily falling to the lower normal limit may mean that poisoning has occured, in spite of the fact that the lowest count still falls within the normal range.

Another effective means of detecting subtle changes is through the use of mass data. Using the example of blood counts again, it may be found that the average of the values for a group of workers having a common exposure is different from that of a group of similar individuals who have had no such exposure. Although this approach may not reveal which individuals in the group have been affected, it will show that excessive concentrations of a noxious agent are present and bring out the necessity for corrective measures. Trends can be used in the interpretation of mass data as well as in following the status of individuals.

(4) *Control Observations.* Although standard values for the normal ranges encountered in the performance of laboratory tests have been published in various textbooks, it is not always entirely safe to use these standards in evaluating occupational exposure to toxic compounds. This principle is universally recognized in biological experimentation, and "control" observations are made to obviate erroneous conclusions. This means that a group to be tested or treated is compared with a similar or identical group under conditions involving a single variable. For industrial toxicology the application of this principle means that if a group of workers is to be tested for possible toxic manifestations, the same tests should also be performed on a group of workers similar in every respect, but not exposed to any potentially toxic agent. Such observations may entail some difficulty, but they are important particularly in interpreting mass data.

(5) *The Importance of Simple Tests.* Some people have a tendency to believe that because a diagnostic test is complicated and involves the use of expensive equipment it necessarily yields information that is of greater significance than that obtained by simpler tests. This is by no means always the case. It is true, of course, that some of the most valuable diagnostic procedures used in industrial toxicology, as well as in ordinary medical diagnosis, are fairly complicated. This should not result in the fact being overlooked that equally important information can be obtained through very simple tests. Not infrequently the simple tests are ignored completely, resulting in diagnostic errors.

New laboratory tests are constantly being developed. Some of these prove to have lasting value, others enjoy a brief vogue and then fall into disuse. A test of proven worth should not be discarded capriciously in favor of a newer one until the latter has conclusively demonstrated its superiority.

(6) *Laboratory Errors.* The performance of diagnostic tests, as well as their interpretation, involves human factors. Anyone who has had any experience with laboratory work is well aware of the many possibilities for error. Some of the more important are listed below.

(a) Errors in Collection. Many diagnostic procedures require the most scrupulous care in the collection of the sample to be tested or analyzed. This is particularly true of specimens to be analyzed quantitatively for heavy metals. The slightest deviation from the approved technique may vitiate the results of the test. The same principle applies to many other laboratory procedures.

(b) Accidental Contamination. A specimen may be properly collected, but may become contaminated after collection and before analysis.

(c) Deterioration. It is always desirable and often essential that a sample be analyzed as soon as possible after collection. Physical, chemical or morphological changes may occur if there is undue delay between the time of collection and the time of analysis. There are methods of preservation which can and should be applied when delay cannot be avoided.

(d) Technical Errors. There is always a possibility, even under the best circumstances, and even when the competence of the technician is unquestionable, for technical errors to creep into laboratory procedures. These can be reduced to a minimum if duplicate samples are analyzed and if "blanks" are run to test the purity of the reagents used.

(e) Errors in Calculation. Some tests require the application of mathematical formulas in the calculation of the results. This introduces a possible source of error.

(f) Mixed Specimens. It is rare, but by no means unknown in busy laboratories, for mistakes to occur in the identification of specimens. This obviously could result in serious error.

(g) Errors in Reporting and Recording. In addition to the erroneous reporting that would result from mixed specimens, there are other possibilities for mistakes. Slips of the pen may occur either when the results of a test are entered on the original report or when these results are transcribed to another document. Illegible writing may be a source of confusion or error.

(h) Wilful Error. The possibility of error as a result of slovenliness or even of outright dishonesty, while rare, should not be overlooked.

The laboratory can be a valuable adjunct to, but should never be a substitute for, medical judgment. When the two appear to be in conflict, it is always wise to check the possibility of error in the laboratory.

The techniques for performing laboratory tests can be found in a number of excellent textbooks. In the discussion which follows no attempt is made to describe techniques.

Common Laboratory Tests and their Significance

An attempt will be made in this section to present, in tabular form, some of the most commonly used laboratory tests together with ranges of normal values. The tests to be considered here are those which are ordinarily performed in any clinical laboratory and which require relatively simple equipment and techniques. The more specialized and complicated procedures will be summarized elsewhere.

The Urine. Laboratory examination of the urine is one of the simplest and at the same time one of the most valuable diagnostic aids. A routine urinalysis should be included as part of the examination of any case of suspected poisoning. Periodic testing of the urine for specific changes is often useful in periodic examinations to detect early evidence of poisoning. The periodic examination need not always embrace a complete urinalysis.

Table 1. Normal Values of Urine

Test	*Range of Normal Values*	*Significance*
1. Color	Pale straw to deep amber	Low specific gravity usually associated with pale color, high specific gravity with a deeper color.
2. Turbidity	Usually clear, if specimen is freshly voided	Turbidity not necessarily an indication of abnormal status.
3. Acidity	pH 4.8–7.5	Fresh urine is usually slightly acid. On standing, urine may become alkaline due to decomposition with formation of ammonia.
4. Specific gravity	1.001 to 1.030	Specific gravity depends on fluid intake. In certain kidney diseases it may become fixed at 1.010.

Table 1. Normal Values of Urine (continued)

Test	Range of Normal Values	Significance
5. Sugar (glucose or reducing bodies)	None	A meal high in carbohydrate may give transient sugar in urine. Its presence does not necessarily mean diabetes.
6. Albumin (protein)	None	Albumin in the urine usually denotes the presence of kidney disease. Occasionally albumin appears in the urine of normal persons following long standing (postural albuminuria).
7. Casts Red blood cells Leukocytes and epithelial cells	0-9,000 in 12 hrs 0-1,500,000 in 12 hrs 32,000-4,000,000 in 42 hrs	In routine examinations of urine a few casts and blood cells may be found in normal specimens.
Kidney Function Tests		
8. Concentration	Sp. gr. above 1.020	A rough, but useful measure of kidney function.
9. Dilution	Sp. gr. 1.002	Same
10. Dye excretion	15 min. 30-50% 30 min. 15-25% 60 min. 10-15% 120 min. 3-10%	Values given are based on intravenous injection of phenolsulfonphthalein (PSP). Low dye excretion means poor kidney function.
11. Porphyrins	Trace	May be increased in exposure to lead.

Interpretation of Urine Tests. Abnormalities in the urine may be caused by diseases of the kidneys or of other parts of the urinary tract: ureters, urinary bladder, urethra and accessory glandular structures. Only when the kidneys themselves are involved will there be disturbances in function. Casts originate only in the kidneys; other formed elements (blood cells, epithelial cells) may enter the urine from other parts of the urinary system. Disturbances in kidney function may not be present unless there has been fairly extensive damage to kidney tissue.

A number of diseases of nonoccupational nature can produce abnormal findings in the urine. Those occupational exposures which may produce urinary changes are listed in Table 2.

Table 2. Occupational Poisons Which May Produce Abnormalities Detectable by Ordinary Urinalysis

Substance	*Findings*	*Significance*
Aniline dye intermediates	Dark color, blood cells	Suggests presence of cancer of bladder
Arsenic	Albumin, blood cells	Due to damage to the kidneys
Benzol	Red blood cells	Severe poisoning with bleeding into urinary tract
Cadmium	Dark color, red blood cells	Due to kidney irritation
Carbon disulfide	Albumin	Kidney damage
Carbon tetrachloride	Albumin, casts, blood cells, impaired function	Due to kidney damage
Cobalt		Questionable
Chlorobenzenes	Albumin, red blood cells, dark color	Kidney damage
Cresol	Albumin, red blood cells	Due to kidney irritation
DDT	Albumin	Kidney degeneration
Dichloroethyl ether		Kidney damage produced in experimental animals
Dioxane	Red blood cells, disturbed function	Hemorrhagic nephritis
Dimethyl sulfate		Kidney damage produced in experimental animals
Ethylene chlorohydrin		Kidney damage produced in experimental animals
Ethylene dichloride		Kidney damage produced in experimental animals
Glycols	Red blood cells, impaired function	Has occured following ingestion
Lead	Increases porphyrins; albumin	Questionable
Mercury	Albumin, impaired function	Due to kidney injury
Methyl bromide	Albumin	Kidney damage
Methyl chloride	Albumin	Kidney damage

Table 2. Occupational Poisons Which May Produce Abnormalities Detectable by Ordinary Urinalysis (continued)

Substance	*Findings*	*Significance*
Methyl formate		Kidney injury has been produced in experimental animals
Naphthols	Albumin, blood cells	Due to irritation of kidneys
Naphthylamines		See Aniline dye intermediates
Nitrobenzol	Albumin, blood cells	Kidney irritation
Oxalic acid	Albumin	Occurs in severe poisoning
Petroleum hydrocarbons		Kidney damage reported in very severe cases of acute poisoning
Phenols	Albumin, blood cells	Kidney irritation
Phenyl hydrazine		Kidney damage in experimental animals
Phosphorus		Kidney damage in severe cases
Tetrachlorethane	Albumin, casts	Due to kidney damage
Thallium		Kidney damage following accidental ingestion
Trinitrophenol		Kidney damage from ingestion
Trinitrotoluol (TNT)	Dark color, albumin, casts, blood cells	Dark color caused by excretion products
Turpentine	Blood cells	Kidney irritation
Uranium	Albumin	Kidney damage
Vanadium	Albumin, blood cells	Kidney damage

The Blood. Laboratory examination of the blood is undoubtedly one of the most important procedures used in industrial toxicology as well as in general medical diagnosis. Many of the techniques for examining the blood are fairly simple and easy to apply. Unlike the kidneys and liver, in which altered function does not occur until there has been serious damage, early and subtle evidence of poisoning can often be detected in the blood.

Standard values for the normal ranges of the various constituents of the blood have been determined and published. These standards have not always been fully appreciated and applied, partly because of the influence of old and obsolete textbooks. As mentioned above, it is often important for an observer to establish his own set of standards when attempting to assess the toxic properties of industrial chemicals. It is important to remember also that abnormalities in the blood may be due to many different causes, nonoccupational as well as occupational.

Table 3. Normal Blood Values

Test	*Normal Range*	*Comments*
Red blood cells		
Males	4.5-6.0 million per cmm	
Females	4.0-5.0 million per cmm	
Hemoglobin		
Males	14-18 g per 100 cc	Values given in per cent are meaningless unless the gravimetric equivalent of 100% is stated.
Females	12-16 g per 100 cc	
White blood cells		
Total	5,000-10,000 per cmm	Total white cell counts fluctuate widely from hour to hour. Differential counts remain fairly static.
Differential		
Band forms	0- 5%	
Segmented	35-70%	
Lymphocytes	20-60%	
Monocytes	2-10%	
Eosinophiles	0- 5%	
Basophiles	0- 2%	
Platelets		
Reticulocytes	0.1-0.5%	High values indicate active blood regeneration
Erthrocyte Sedimentation Rate (ESR)	Wintrobe method Males 0-9 mm in 1 hr Females 0-20 mm in 1 hr Westergren method Less than 20 mm in 1 hr	Values differ in males and females
Hematocrit	40-48% cell volume	Affected by dehydration
Mean Corpuscular Volume (MCV)	80-94 cu. microns	Average size of red blood cells
Mean Corpuscular Hemoglobin (MCH)	27-32 micromicrograms	Average hemoglobin content per cell
Mean Corpuscular Hemoglobin Concentration (MCC)	32-38%	Average concentration of hemoglobin in red blood cells
Red Cell Fragility	Hemolysis starts in solution of 0.42% NaCl, complete in 0.32% NaCl	
Bleeding Time	Less than 3 min.	Capillary bleeding
Coagulation Time	6-10 min.	Venous blood
Appearance of red blood cells	Uniform size and staining, appear circular	Parasites such as those of malaria may be found in stained blood smears.

Table 4. Normal Blood Chemistry Values

Test	*Normal Range*	*Comments*
Blood Urea Urea Nitrogen	20-35 mg per 100 cc 9-17 mg per 100 cc	
Non Protein Nitrogen (NPN)	15-40 mg per 100 cc blood	
Total Protein (L.F.)	6.0 – 8.0 g per 100 cc	
Serum Albumin (L.F.)	4.0–5.0 mg per 100 cc	
Serum Globulin (L.F.)	2.0–3.5 mg per 100 cc	
Albumin-globulin Ratio (A/G) (L.F.)	1.5:1 to 3:1	
Uric Acid	2-4 mg per 100 cc blood	
Total Cholesterol (L.F.)	150-230 mg per 100 cc	Increased in biliary obstruction, decreased in diseases of liver
Cholesterol Esters (L.F.)	65-75% of total cholesterol	Decreased in liver disease
Serum Bilirubin (L.F.)	0.4-1.5 mg per 100 cc of serum	Elevated in biliary obstruction
Alkaline Phosphatase (L.F.)	3.0-4.5 Bodansky Units per 100 cc of serum	High values in biliary obstruction. Little change in intrinsic liver disease.
Acid Phosphatase	0.5-2.0 Gutman Units per 100 cc of serum	Not related to liver disease
Blood Sugar	90-120 mg per 100 cc blood	
Icterus Index (L.F.)	2-8 units	Frequently used as a measure of jaundice, but unreliable because of interfering substances.
Calcium	8.5-11.5 mg per 100 cc serum	
Chlorides	570-620 mg per 100 cc plasma	
Creatinine	1-2 mg per 100 cc blood	
Oxygen Capacity	18-24 cc per 100 cc blood	

Table 4. Normal Blood Chemistry Values (continued)

Test	*Normal Range*	*Comments*
Potassium	16-22 mg per 100 cc serum	
Sodium	315-330 mg per 100 cc serum	
Phosphorus	3-4 mg per 100 cc serum	Inorganic phosphates

Tests marked (L.F.) are used in liver function studies.

Disturbances in the Blood Due to Occupational Poisoning. In this section attention will be limited to those components of the blood included in Table 3. The tests involved can be and usually are performed in any clinical laboratory. Some toxic materials affect several of the blood elements while others produce changes in a single component. Table 5 represents an attempt to summarize the hematologic abnormalities that may be caused by occupational exposure to toxic compounds.

Table 5. Occupational Poisons Which May Produce Abnormalities Detectable by Studies of the Blood

Substance	*Findings*	*Comments*
Acrylonitrile	Anemia, leukocytosis	Reported but not definitely established.
Aniline	Anemia, stippled red cells, leukocytosis	Findings differ in acute and chronic exposure.
Antimony	Leukopenia	Effects may resemble those of arsenic.
Arsenic	Anemia, leukopenia	Industrial poisoning may be caused by arsine.
Benzene	Decrease in all formed elements	Death may result from depression of the bone marrow.
Carbon disulfide	Anemia, leukocytosis, immature W.B.C.	Conflicting reports in medical literature.
Carbon tetrachloride	Anemia, leukopenia	Questionable
Cobalt	Increased R.B.C.	Animal experiments only.
DDT	Anemia, leukopenia	Rarely occurs.
Ethyl silicate	Anemia, leukocytosis	Animal experiments only.

Table 5. Occupational Poisons Which May Produce Abnormalities Detectable by Studies of the Blood (continued)

Substance	*Findings*	*Comments*
Ethylene glycol monomethyl ether	Decrease in all formed elements, increased percentage of immature W.B.C.	Based on human observations
Ethylene oxide		Questionable
Lead	Mild anemia, stippling of R.B.C.	Well established
Manganese	Leukopenia	Questionable
Mercury	High hemoglobin	Reported but unconfirmed
Methyl chloride	Decrease in formed elements	Animal experiments
Nitrobenzenes (Nitrophenols)	Reduced R.B.C with signs of regeneration	Due to blood destruction
Nitrous fumes	Decreased W.B.C.	Reported but unconfirmed
Phenylhydrazine	Anemia with signs of regeneration	Due to blood destruction
Radium	Decrease in all formed elements	Well established in humans
Selenium	Anemia	Animal experiments
Tetrachlorethane	Signs of blood destruction	Not fully established in humans
Thallium	Increased W.B.C. and eosinophiles	Reported but unconfirmed
Thorium	Decrease in all formed elements	Due to radioactivity
Toluene	Anemia, leukopenia	Mild when compared with benzene
Toluidine	Anemia	Questionable
Trichlorethylene	Anemia	Reported but unconfirmed
Trinitrotoluene	Anemia, leukopenia	Well established
Uranium	Anemia, leukopenia	Due to radioactivity
Vandium	Anemia	Questionable
Xylene	Anemia, leukopenia	Questionable

Interpretation of Laboratory Tests on Blood. The interpretation of laboratory tests on the blood should be governed by the basic principles which apply to all laboratory diagnostic procedures (see p. 13). In particular, the importance of normal or control observations should be stressed. Furthermore, there is nothing specific about blood examinations which permits a conclusion that if abnormalities are found in a worker who has been exposed to a known hemotoxic agent that the change is necessarily due to the poison. At best, the evidence is only presumptive and forms only a part of the total picture.

Since complete laboratory examination of the blood is somewhat time-consuming it is often impracticable to perform complete studies on large groups of workers. As a routine procedure, determination of the hemoglobin and examination of a stained blood smear may be useful. The combination of these two tests will reveal or give a clue to the existence of most abnormalities of the blood. Single tests or partial examinations are often all that are required in periodic examinations to detect early poisoning. In cases where differential diagnosis is involved, more complete blood studies are usually required.

Liver Function Studies. As mentioned elsewhere, disturbances of liver function detectable by laboratory methods may not be present until there has been a substantial degree of damage to the liver. This means that liver function tests are of very limited value in detecting early poisoning and that normal results in liver function studies do not necessarily mean that the liver is intact.

A variety of causes may produce abnormalities in liver function and it is often difficult to determine the causative factor. In studying liver function it is customary to perform a battery of tests. Various combinations of positive and negative results are helpful in arriving at an opinion or conclusion as to the true nature of the disease process.

Some of the tests which are frequently used in studying liver function have been included in Table 4 page 20. Some of the more specific tests are summarized in Table 6. Interpretation should be guided by the general principles set forth on page 13.

Table 6. Liver Function Tests

(Other than those given in Table 4.)

Test	*Normal Range*	*Comment*
Bromsulfonephthalein test (BSP)	Less than 5% retention	Disease of liver tissue, biliary obstruction or circulatory obstruction may cause greater retention
Cephalin Flocculation	0-1+ flocculation in 48 hrs	Increased flocculation found in disease of liver tissue, associated with abnormalities of serum proteins
Thymol Turbidity	0-4 Maclagan units	Significance same as cephalin flocculation
Tabata-Ara test	No definite flocculation in any dilution	Significance same as cephalin flocculation and thymol turbitity
Urine Urobilinogen	0.5-2.0 mg per 24 hrs or dilution of 1:4 - 1:30	May be abnormal in biliary obstruction or in disease of liver tissue

Table 7. Occupational Poisons Which May Produce Abnormalities In Liver Function

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Acrylonitrile
Antimony
Arsenic*
Beryllium*
Cadmium*
Carbon disulfide*
Carbon tetrachloride*
Chlorinated diphenyls*
Chlorinated naphthalenes*
Cobalt
Cycloparaffins
  (cyclopropane, -butane, etc.)
Diethylene dioxide* (Dioxane)
Dinitrophenol*
Diphenyl
Ethylene chlorohydrin
Ethylene dichloride
Methyl chloride*
Methyl formate
Methylene chloride
Nitrobenzol*
Phenol*
Phenylhydrazine
Phosphorus*
Tetrachlorethane
Trichlorethylene
Trinitrotoluene*
(TNT)
Uranium

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*Substances marked with an asterisk have been shown to produce liver injury.

Table 7 is a list of substances commonly used in industry which may produce injury to the liver and consequently may, in severe poisoning, result in abnormal liver function. This list is given without further comment since available pertinent information is somewhat limited. For many of the substances listed, the evidence is confined to observations on experimental laboratory animals.

Miscellaneous Tests of General Importance. *Serological Tests for Syphilis.* Testing the blood for evidence of past or present syphilitic infection is commonly practiced as part of a preplacement or routine periodic physical examination. The oldest and best known of the blood serological tests is the Wasserman reaction. In recent years there have been developed a number of modifications of the Wasserman test, such as the Kolmer, Kahn, Kline, Mazzini, Hinton, Eagle and V.D.R.L. tests. All of these are applied for the same purpose, i.e., to detect syphilis.

In the interpretation of serological tests for syphilis there are a few principles which are particularly important:

(1) Conclusions should not be drawn or therapy instituted as a result of a single positive report. Before action is taken, the test should be repeated and perhaps one or more of the modified forms of the test done as well.
(2) A positive test, in and of itself, does not necessarily mean that there has been a syphilitic infection. Positive reactions can be caused by other diseases (e.g., malaria) and furthermore there occasionally occur false positives.
(3) A negative test does not necessarily rule out the possibility of syphilis. It takes time for the blood to develop the antibodies which produce positive reactions so that in the very early stages of the disease a positive test may not be obtained. In such cases a dark field examination of material obtained directly

from a suspected lesion may reveal the presence of the spirochaetes which cause syphilis. False negative reactions are rare, but can occur.

(4) A positive reaction may be found in persons who have had syphilis even though they have received adequate treatment and to all intents and purposes have been cured. This condition is known as being "Wassermann fast." A positive test, then, does not necessarily mean the presence of active disease.

(5) The various serological tests have a relatively high degree of specificity but are, nonetheless, subject to all of the possible errors and pitfalls of any laboratory procedure (see page 14).

Other Serological Tests. Tests performed on the blood serum may provide valuable diagnostic evidence in a number of infectious diseases. Some of these may be occupational in origin, such as brucellosis (undulant fever), tularemia, Weil's Disease (spirochaetal jaundice), psittacosis, and glanders.

Interpretation of the results of serological tests applied to these infections should be in accordance with the general principles stated on page 13.

Bacteriologic Examinations. This category includes direct examination of stained or unstained material such as sputum, pus or urine sediment and the study of cultures of suspected specimens having the same general origin. These tests are usually applied as part of a general diagnostic study. Yeasts, molds, and fungi may be studied by methods similar to those applied to bacteria.

Infectious diseases of occupational origin, in addition to those mentioned previously, include anthrax, tetanus, rabies, erysipeloid, blastomycosis, actinomycosis, moniliosis, coccidioidomycosis, aspergillosis and cryptococcal infection.

Stool Examination. Fresh or stained specimens of the stools (feces) are often examined to detect the presence of intestinal parasites such as worms or amoebae. A search is made either for the parasite itself or its eggs. Another common test applied to the stools is that for blood, to secure evidence of cancer or other lesions of the gastrointestinal tract.

Interpretation of stool examinations should be guided by the general principles of all laboratory diagnostic procedures (see page 13).

Electrocardiogram (EKG). This test has found wide application in the diagnosis of heart disease. The reading or interpretation of an electrocardiogram requires a high degree of skill. There is nothing magical about the instrument which produces the electrocardiogram, the electrocardiograph. All it can do is to give a record of the manner in which a nerve impulse travels through the heart muscle. Disturbances of the conduction system and abnormalities of the heart muscle may produce characteristic abnormalities of the electrocardiogram. A normal tracing does not necessarily mean that there is nothing wrong with the heart, and an abnormal tracing does not necessarily mean that heart disease is present.

Basal Metabolic Rate (BMR). This is a method for measuring the rate at which oxygen is consumed by the body. Its most frequent application is in the study of suspected or actual diseases of the thyroid gland. Many conditions other than thyroid disease can produce abnormalities of the BMR.

Roentgenologic (X-ray) Examinations. The use of the x-ray has wide application as a diagnostic tool. It is important to realize that all the x-ray can do diagnostically is to provide a record of the density of the structures through which the rays pass. Dense objects obstruct the passage of the beam, resulting in less darkening of the film. The darker areas on an x-ray film are those through which the rays pass most readily. The usefulness of the x-ray can be enhanced by the use of radio-opaque contrast media, such as the familiar barium mixtures used in the roentgen examination of the intestinal tract.

The basic principles of the interpretation of laboratory tests apply to the interpretation of data obtained by roentgenologic examination.

Special Laboratory Tests. In the previous pages a summary has been given of the more important laboratory procedures which are used in medical diagnosis. These tests are used in studying nonoccupational as well as occupational illnesses. There are, in addition, a number of tests which are utilized only in the diagnosis of diseases caused by noxious substances. Exposure to such substances occurs principally as an occupational hazard although occasionally there is a nonoccupational origin. Examples of the latter would be the inhalation of toxic gases produced by faulty heating or refrigerating equipment or the ingestion of poisonous materials in contaminated food and beverages. Occupational poisoning may occur in the practice of hobbies or through work in one's own home and is not necessarily the result of adverse conditions of employment.

There are two main types of tests used to detect the absorption of potentially harmful substances.

(1) Detection of the material itself in body fluids, particularly in urine and blood. This is used principally in connection with metallic poisons.
(2) Detection of the products of metabolism (metabolites) of a toxic substance. This is used principally in connection with toxic organic compounds.

In addition to these two main types there are several of lesser importance such as:

(3) Examination of expired air for the detection of toxic gases.
(4) Examination of sputum for dust particles or asbestosis bodies.
(5) Stool examination for heavy metals.
(6) Biopsy examination of living tissue.
(7) Post mortem examination (autopsy) and chemical analysis of organs.

The general principles of interpretation (see page 13) apply to the special tests as well as to all others. Of particular importance is the avoidance of contamination of specimens. Many of the analytical procedures used in determining toxic substances in blood and urine are so sensitive that the slightest error in the technique of collecting and handling the specimen can vitiate the results of the analysis.

"Normal" Content of Metals in Urine and Blood. A number of metals which can cause occupational poisoning may be found in the urine or blood of persons who have had no occupational exposure to these substances. Lead, arsenic and mercury are common examples of this. Extensive studies on lead have shown that the so-called "normal" content may be as high as 0.08 mg per liter in urine and 0.05 mg per 100 cc in blood. Reliable quantitative data of a similar nature are not available for other metals.

In interpreting the results of analyses of blood and urine for heavy metals a few points are particularly important.

1. The presence of a toxic metal indicates absorption but not necessarily poisoning.
2. The metal could have gained access to the body from nonoccupational as well as occupational sources.
3. It is important to know the amount of concentration of toxic metal, not merely whether it is present or absent.
4. The concentration of a toxic metal in the blood is more likely to be correlated with symptoms and signs of poisoning than the quantity or concentration in the urine. For lead there tends to be fairly good correlation between blood and urine levels and between these values and clinical manifestations. For mercury this is not the case. Information on other metals is very scanty.

Table 8. Materials for Which Analysis of Urine and Blood Is Useful

Substance	*Normal Range*	*Comment*
Arsenic, Urine	0-0.85 mg per liter	Arsenical medication can result in arsenic appearing in urine and blood
Fluoride, Urine Blood	0.2-0.4 mg per liter < 0.01 mg per liter	Fluorine content of drinking water is important
Lead, Urine Blood	0.01-0.08 mg per liter 0.01-0.05 mg per 100 cc	Average 0.03 mg per liter Average 0.03 mg per 100 cc
Mercury, Urine	none	Amalgam fillings in teeth may give detectable quantities in urine.
Selenium, Urine	0-0.10 mg per liter	Depends on soil content of selenium
Carbon monoxide, Blood	0-10%	CO measured as carboxyhemoglobin

Table 9. Common Urine Tests for the Presence of Metabolites

Metabolite	*Agent*	*Normal Range*	*Comment*
Sulfates	Aniline Benzene Phenol Xylidine	Inorganic sulfate 85-90% Organic sulfate 10-15%	Can be influenced by diet. Can be influenced by diet.
Hippuric acid	Toluene Ethylbenzene	0.6-0.7 g in 24 hrs	Also present in other benzene homologs which are oxidized to benzoic acid
Glucuronates	Aniline Benzene Phenol Terpenes Xylidine	0.7-1.4 g in 24 hrs	
Trichloracetic acid	Trichlorethylene		
Formic acid	Methyl alcohol	30-120 mg in 24 hrs	
Thiocyanate	Nitriles	0-14 mg in 24 hrs	Influenced by smoking
2, 6-Dinitro-4-amino-toluene	TNT	none	
p-Aminophenol	Aniline	none	
DDA	DDT	none	Acetic acid metabolite of DDT

SECTION 2

VENTILATION CONTROL

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Estimation of Hazard

In the industrial use of materials which possess toxic properties, care must be taken to prevent exposure above and beyond some predetermined safe level. In assigning a safe or maximum allowable concentration, MAC, it is generally assumed that this level may be endured by the most susceptible individual with no apparent ill effects. In some cases, it is possible that this MAC is not properly chosen, but until better information is available, it may be used as a design criterion for control of the hazard involved in its use.

Prior to any attempt to engineer the control of a hazard, some effort must be made to define the type and extent of this hazard. An industrial hygiene engineer with broad experience in handling toxic substances can generally make a reasonable evaluation from a consideration of the process and the materials involved, and estimate the potential hazard. This sort of estimate, however, is at best semi-quantitative and for economy should be followed by a careful instrumental evaluation. Also, after any control equipment or procedures have been instituted, it is generally well worth reevaluating to insure the adequacy of these controls. It will often be found that if consideration of the methods discussed in this section is given in the order presented, the most economical control will result. (For Hazard Ratings see Tables 5 and 6, pp. 50-51.)

Substitution of Materials

After a survey of a process has indicated that one or more items constitute a potential hazard, thought should be given to the substitution of other, equivalent materials with a lower order of toxicity. In most cases this is unlikely to be successful. However, sometimes equivalent or nearly equivalent results can be obtained by using materials of substantially lower toxicity. For example, many years ago the hazards of white phosphorus in match heads was eliminated by the substitution of red phosphorus which is less dangerous. Many paint pigments historically based on white lead are now composed of zinc, titanium or barium oxides, and are equally effective. The undisputed excellence of benzene as a solvent is challenged by combinations of paraffinic materials which have a much lower hazard rating. For the same reason, carbon tetrachloride has been replaced in large measure by other chlorinated hydrocarbons. The economy of this procedure cannot be overly stressed. Where control requirements are large, significant savings can be made.

For many years, the carroting of fur used in making hatters' felt resulted in extensive mercury poisoning. During the 1930's the degree of this hazard was recognized and some research was devoted to the development of a carroting agent which was nonmercurial. The resistance encountered in getting the industry to revise its practices was great until the rising costs of mercury forced the industry to abandon mercurial carroting agents.

In a similar manner, early workers with fluorescent phosphors found that certain of the beryllium silicates were very efficient in transposing ultraviolet radiation into visible light. For several years, thereafter, beryllium was a primary constituent of fluorescent tubes. By the middle 1940's berylliosis was discovered not only among those engaged in the manufacture of tubes but also in the innocent population living near the manufacturing plants. Soon the financial pressure of liability claims forced the discontinuance of beryllium. Other phosphors were investigated and these have since been improved to an equivalent degree of efficiency.

Isolation or Segregation of Personnel

The process or equipment giving rise to hazardous exposures may sometimes be segregated so as to reduce either the extent of individual exposure or the number of individuals exposed. Such segregation might take the form of isolation in space or in time. A furnace, for example, represents isolation in space. Conducting dangerous procedures during off-shift time is an example of isolation in time. It is often possible to use the principle of isolation in space by building the offending equipment into a room by itself, or in the case of existing equipment, an enclosure may simply be built around it. When, as often happens, the most hazardous part of the process does not require personal supervision, the operation may be placed in a separate room or inside an enclosure and the work brought to it by a mechanical conveyor. In many cases, the number of exposed persons may be reduced to a single operator or group of operators simply by segregating the more dangerous equipment from the rest of the plant personnel. Isolation in time is often used in small foundries where all the molds are poured during the main shift and the dusty and potentially hazardous shake-out operation is performed during the second shift by a reduced staff. When the major portion of an operating procedure involves more toxic materials, it is sometimes possible to perform most of the operations by remotely actuated devices. Fully automatic chemical plants are frequently designed on this basis, so that all operating personnel are located in control rooms far from the hazard areas.

Local Suppression of Materials

When a substance becomes hazardous to personnel because it is dispersed into the atmosphere, it is frequently possible to reduce the amount which gets into the air by blanketing the originating surface. Thus, toxic materials having a high vapor emission rate when exposed via large open surfaces can be covered with lighter, immiscible nontoxic materials having a low vapor pressure. For example, liquid mercury at room temperature can create a very serious mercury vapor hazard. Covering the mercurial surface with water can reduce this hazard significantly.

Mechanical suspension of mists has been successfully controlled by means of insoluble floats. For instance, plastic beads or foams are frequently used to cover the surface of chromium plating baths, thereby reducing the loss of valuable chromic acid through misting and incidentally materially reducing the need for ventilation. This principle has also been applied to volatile fuel tanks.

Water has been successfully used as a suppressant for many kinds of dust where the operation is such that the dust can be wetted. It is frequently possible to change a characteristic of the material which may be evolved to suppress its evolution. Where dusty materials are handled, binders can be introduced which, in some cases, will make dispersion less likely. Pelletizing of finely divided materials like carbon black has also been used successfully to reduce inhalation hazards from flying particles and increase cleanliness.

Control of Air-borne Materials

As has been described in Section 1, the most dangerous and also the easiest way for toxic materials to enter the body is via the respiratory system. A dangerous concentration can be absorbed without the individual's knowledge or conscious participation. On reviewing the materials which industry considers hazardous, it appears that a large proportion of these are produced industrially as dust, fume, gas or mist. Such materials can be air-borne and can readily enter the body.

Because of the ease with which air-borne materials may enter the body, and because of the relatively rapid and complete assimilation of such material, toxicologically dangerous quantities in the air are usually of a relatively low order of concentration. An analysis of permissible air-borne concentrations reveals that most are presented in parts per million and not in percentage points. Air-borne materials in relatively low concentrations have several important properties in common which largely govern their behavior in the air; these properties also govern the application of engineering control to prevent their dissemination in the workroom. Briefly, these properties may be defined as resulting from the following:

(a) Heat or cold, together with the usual convection currents created thereby.

(b) Any air current, draft, or other air movement caused by a pressure differential, convectional force or by the motion of some physical body such as a machine, a machine part, or a person.

(c) Gravity. It is important to recognize that whereas the force of gravity is important when it acts on solid or liquid particles of 20 microns in diameter or larger, smaller particles down to gas molecules are much more likely to ride on stray turbulent air currents and will only settle in response to gravity when the air in a space is unusually still. Thus, heavy gases or vapors, or heavy concentrations of dust will not usually collect or stratify at the floor, nor will lighter air-borne material concentrate near the ceiling unless the space is much quieter than the usual industrial work area or area where heat is produced.

(d) The initial projection velocity of the material is a function either of the process or the machine or of the circumstances under which the solid particle or gas is generated. Examples of this effect would be material issuing from a jet or nozzle or being thrown by a high-speed cutter or other high-speed machine or machine part. A spinning wheel or similar device will frequently create an air motion just as a fan does and this air motion can effectively throw material out from the wheel's rim at a high velocity. It should be pointed out, however, that whereas a large particle which has significant mass will remain projected for quite a distance, it will slow down and stop as soon as its initial energy is dissipated. Most particulate materials of hygienic significance, because of their small mass, slow down rapidly, becoming a part of the air stream.

A substance which is so dispersed as to be of hygienic significance (a gas, vapor, or small dust or mist particles) will generally tend to diffuse throughout any contained space and will eventually fill the space into which it has been released in approximately uniform concentration. This does not mean that there will not be spaces of lower or higher concentrations depending on the various factors which govern the release and distribution of the material. It does mean, however, that it is unlikely that any gaseous material or air contaminant which resembles a gas can be expected to spill like a liquid. Rather, its motion can be predicted on the basis of the movement of air currents, because the material will nearly always move with these currents and be completely at their mercy.

If the statements in paragraphs (a) and (b) above are accepted, it follows that a single basic principle applies to all problems of ventilation control: If the air containing the contaminating substance is in motion the contaminating agent will likewise be in motion in the same direction and at the same velocity; if the air containing the contaminating material is removed, the material is removed; if air containing the contaminant is in part replaced, the concentration of contaminant in the atmosphere will become more dilute; if the air which contains the contaminant can be completely contained and not permitted to travel through the work space, the danger from the contaminant is eliminated except within the containing enclosure.

Because contaminants are airborne the usual means for their control is ventilation, defined broadly as "the process of supplying or removing air by natural or mechanical means to or from any space; such air may or may not have been tempered or conditioned." Ventilation may be divided into two general categories depending upon the means of application: general ventilation (sometimes known as dilution ventilation) and local ventilation, which is almost always applied as exhaust, although local pressure ventilation can sometimes be used. Both these categories fall within the definition given above.

General Ventilation. General ventilation consists of the removal of air from or the supply of air to a general area. This area may be a room or a building, but is usually only a portion of an enclosed space. General ventilation may be induced by natural means as, for example, a fireplace chimney, or by a mechanical air-moving device, such as an air conditioning system. It may be created by forcing air into a space or by removing air from a space. An example of the first is the usual household forced hot-air system wherein warm air is blown into a space to dilute the cold air. The latter may be represented by an attic fan used to remove hot convected air from the upper portions of a building, permitting it to be replaced with cooler air from ground level.

In any event, the primary purpose of general ventilation is to dilute some physical factor, such as heat or cold, or a concentration of material, for the purpose of promoting comfort or health or removing a nuisance. There are, however, certain limiting factors which make the use of general ventilation impractical; and if we define the term "contaminant" as any undesirable factor contained in an atmosphere, the limits may be stated generally as follows:

(a) The quantity or concentration of a contaminant must not be so great that too large a quantity of air will be necessary to dilute it to a safe or comfortable level.

(b) The rate of generation of the contaminant in the space should be reasonably uniform.

(c) The source of generation of the contaminant should be distributed throughout the space and should not arise from a single small local source.

(d) General ventilation should not even be considered when the contaminant is highly toxic.

(e) The contaminant should not be generated in the immediate vicinity of a space normally occupied by people; this might create concentrations higher than those found in the room average.

(f) At best, it is difficult to predict the potential reduction in concentration of a contaminant as a result of general ventilation. It is not customary therefore to use this method unless the material being generated merely causes discomfort, is a nuisance, or because of visual obscurance.

A careful study of the above limitations indicates that most of them have to do with a "practical" or "economical" quantity of air. In most cases, these limitations can be neglected if there are no economic or other limitations on the quantity of air which can be removed from the space. These limitations include:

(a) Power consumption in operating air-moving equipment.

(b) Heating the incoming air to replace heat which is taken away by the air removed from the space.

(c) Air velocity which might be directed against people and create sensations of draft.

(d) Size of available openings through which the quantities of air would have to move.

There are occasions when none of these objections govern. For example, while working on a tropical island with consistent, moderately strong unidirectional winds it is possible to carry on dangerous operations out-of-doors, either with or without shelter from the elements. It is even possible to carry on such potentially dangerous operations as spray painting, sandblasting, and paint removal. Those which involve use of highly toxic aromatic hydrocarbon solvents have been successfully carried out with natural, general ventilation under conditions similar to those described above.

Despite the limitations of this type of control, there are many circumstances under which general ventilation provides a satisfactory means for reducing a hazard. A few such circumstances will be described briefly:

(a) When the nature of an operation or process either prohibits, makes impractical or very difficult the application of local exhaust ventilation or location ventilation of any type, general ventilation may be the only means available to remove the contaminant.

(b) When it is more important to keep the first cost of installation low than it is to maintain operating costs at a minimum. This is often the case when an operation is intermittent or is intended for a relatively short term.

(c) It is sometimes true that the initial installation as well as operation and maintenance of general ventilation is more economical than local exhaust ventilation. This is especially true where heat or hot gases are involved.

(d) When the volume of the contaminant is large compared to the volume of the work space, or when it is generated throughout the entire workroom area, or from an accumulated total of surfaces which are large compared to the total room area.

In view of the above it is possible to outline certain specifications which should be met before general ventilation can be used effectively. It is advisable to examine the area to be ventilated carefully and to meet as many as possible of the following conditions:

(a) The fan or other source of air movement (roof ventilator, chimney, louvre or window) used to supply or to remove air from the work space should be located as close as possible to the source generating the material.

(b) A general ventilation system may involve either suction (pull) or pressure (push). It is necessary to replace the air removed by suction or remove air introduced by pressure. Air may be replaced or removed by opening doors or windows, or by a completely distributed supply air system with means for tempering and conditioning the air introduced. It should be pointed out that any resistance imposed on air entering the space, if exhaust is used, or any significant restriction of air leaving the space, if ventilation is supplied, should be considered as a resistance of the entire system. For example, air removed through a natural draft chimney may be supplied through an open door. If there is no other entry into the space, closing this door will effectively close off the chimney and thereby substantially reduce the air flow. If the air is moved by a mechanical draft blower or exhauster, the resistance of the intake or the discharge end must be computed as a part of the fan resistance.

(c) It is important, wherever practical, to locate the source of suction so that no operator or workman would normally stand between the source of contamination and the opening through which the air will leave.

(d) The exhaust port should be so placed that contaminated air discharged from the work space does not have an easy path for re-entry. It should be borne in mind that when large quantities of air are being removed from a workroom, the space from which the air is taken is under negative pressure and outside air will enter through any available opening. If air in the vicinity of an opening, such as a window or door, is contaminated with material discharged from the room, it is very likely that this contaminated air will re-enter the room through that opening. When the quantity of air being removed is large, it should not be discharged into a closed shaftway or air-way because open windows may provide an easy path for re-entry of the contaminant into the work space or any other area.

(e) Any air which enters the space to make up that which has been removed should be treated in such a way as not to create uncomfortable drafts. Although an uncomfortable draft is difficult to define, it is generally created by a large temperature differential between normal work-

Table 1

Note: The tabulated dilution air quantities must be multiplied by the selected K value.

Solvent	MAC	Cu. Ft. Air Required For Dilution to MAC	
		per pint evaporated	per pound evaporated
Acetone	1000	5,500	6,650
Amyl acetate	200	13,600	14,900
Benzol	35	not recommended	
n-Butanol	100	not recommended	
n-Butyl acetate	200	15,300	16,600
Butyl "Cellosolve"	200	15,400	16,400
Carbon disulfide	20	not recommended	
Carbon tetrachloride	25	not recommended	
"Cellosolve"	200	20,800	21,500
"Cellosolve Acetate"	100	29,700	29,300
Chloroform	100	50,200	32,400
1,2,Dichloroethane	100	not recommended	
1,2,Dichloroethylene	200	26,900	20,000
Dioxane	100	47,300	43,900
Ethyl acetate	400	10,300	11,000
Ethyl alcohol	1000	6,900	8,400
Ethyl ether	400	9,630	13,100
Gasoline	500	7,000	10,000
Isoamyl alcohol	100	37,200	43,900
Isopropyl alcohol	400	13,200	16,100
Methyl alcohol	200	49,100	60,500
Methyl acetate	200	25,000	26,100
Methyl butyl ketone	100	33,500	38,700
Methyl "Cellosolve"	25	not recommended	
Methyl "Cellosolve Acetate"	25	not recommended	
Methyl ethyl ketone	200	22,500	26,800
Methyl isobutyl ketone	100	32,300	38,700
Methyl propyl ketone	200	19,000	22,400
Naphtha (coal tar)	200	19,000	25,000
Naphtha (petroleum)	500	7,000	10,000
Nitrobenzene	1	not recommended	
Propyl acetate	200	17,500	18,900
Stoddard solvent	500	7,000	10,000
Tetrachloroethane	5	not recommended	
Tetrachloroethylene	200	19,800	11,700
Toluol	200	19,000	21,000
Trichloroethylene	200	22,500	14,700
Xylol	200	16,500	18,200

room air and the incoming stream, or by the velocity of the stream within the space, or both. It is generally conceded that no drafts will be experienced when the temperature differential between the incoming stream and the normal workroom temperature is limited to 10°F. Drafts will be experienced only when the incoming air temperature is lower than the room temperature. Another limitation which should be placed on the incoming stream is that it should not strike any individual at a velocity greater than 200 linear feet per minute.

As a rule, when the type of ventilation which is being discussed here is used to control potentially toxic exposures, the contaminant is in the form of a gas or vapor. The control of vapors arising from volatile liquids is a common example. General ventilation is also frequently used to remove excess quantities of heated air produced within a work space.

In either of these cases, dilution ventilation can be used to greatest advantage. Dilution ventilation is merely another term for general ventilation; its primary purpose is to mix the unwanted contaminant (toxic vapors or heated air) with large quantities of clean fresh air so that the resulting concentration will not be dangerous or uncomfortable. For example, when a solvent material of rather low toxicity is evaporated into a work space, dilution can be used. If the total quantity of such a material consumed in a given time is known or can be determined, the following equations* may be applied to find the quantity of general ventilation necessary to meet any predetermined health standards (MAC).

The air dilution volume for various solvents may be calculated using the following formulas:

$$V_v = \frac{403 \times \text{SpG} \times 10^6 \times K}{m \times \text{MAC}} \qquad (1)$$

$$V_w = \frac{387 \times 10^6 \times K}{m \times \text{MAC}} \qquad (2)$$

K = A constant. A function of the toxicity of the solvent in question, uniformity of distribution, dilution of vapors in air, location and proximity of fan to evolved vapors, population of areas, etc. It may vary from 3 to 10.
SpG = Specific gravity of solvent
m = Molecular weight of solvent
MAC = The parts of vapor of solvent per million parts of air by volume to be allowed
V_v = Volume (in cubic feet) of air required per pint of solvent evaporated.
V_w = Volume (in cubic feet) of air required per pound of solvent evaporated.

Table 1 lists the number of cubic feet of air required to dilute to maximum allowable concentration on evaporation of the amounts of materials noted. The maximum allowable concentration values are given in parts of material per million parts by volume of air. The MAC values are those recommended by the American Conference of Governmental Industrial Hygienists for 1956 and are subject to revision. Any change in the MAC value will require a corresponding change in the dilution air requirements which may be calculated from the above equations.

A major disadvantage of general ventilation, as well as a major source of cost in its application, arises from the fact that it is successful only when relatively large quantities of air are exhausted from the space. When air is moved through a work space for the primary purpose of diluting the concentration of any contaminating substance, it will dilute any heated air which is in the space. Every cubic foot of air removed from a workroom area will carry with it some of the heat contained in the space. When the outside temperature is significantly below the temperature of the workroom, such removal of heat will result in an uncomfortable atmosphere. The only way in which this discomfort can be reduced is to replace the heat which has been removed. This can be done if a relatively few simple factors are taken into account. From the following equation it is possible to compute the cost per hour to operate the heating equipment which would be required to replace the ventilation loss.

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* From "Industrial Ventilation, A Manual of Recommended Practices," prepared by the American Conference of Governmental Industrial Hygienists, 3rd Edition, 1954.

$$C_h = \frac{HQC}{h} \qquad (3)$$

where:
C_h = Cost per hour in dollars
H = Btu per hour per cfm (see Table 2)
Q = Cubic feet per minute (cfm)
h = Btu per unit of fuel (see Table 3)
C = Cost per unit of fuel in dollars.

Table 2

Outside Average Temp. (°F)	Btu/hr/1000 cfm)
0	72,000
5	67,000
10	62,000
15	57,000
20	52,000
25	47,000
30	42,000
35	36,000
40	31,000
45	26,000
50	21,000
55	16,000
60	11,000

Tables 2 and 3 and the above equations are based on maintaining an indoor temperature of 70°F. The average outdoor temperature may be obtained from the proper tables. A degree-day map can be obtained from which the total number of degree days per year may be derived. With the number of degree-days for which heating is required and Equation (2), it is possible to set up another equation wherein the annual cost of heating the air per pound of solvent evaporated may be computed.

$$C_y = \frac{K \times N \times 10^{10} \times C \times D}{m \times h \times 422 \times MAC} \qquad (4)$$

where:
C_y = Cost per year in dollars
K = As above
N = Average weight of solvent evaporated per year in pounds
C = As above
D = Degree days
MAC = As above
m = As above
h = As above

The above calculations indicate that the cost of diluting a toxic material released into a work space may be high. Hence in designing exhaust systems every effort is made to reduce the amount of air required to control the hazard successfully. The art of local exhaust ventilation design lies almost entirely in using exhaust hoods to minimize the number of cubic feet of air which must be removed from the space every minute, at the same time providing a maximum of free and unencumbered access to the operation. Subsequent pages will outline the factors involved in designing local exhaust systems.

Local Exhaust Ventilation. A local exhaust system is commonly used to remove air-borne contaminating substances from a work space. Individual systems may vary a great deal in their concept and execution. Basically, however, such a system consists of several fundamental components which may be described as follows:

(a) A hood, booth, or enclosure of suitable design, located at or near the point of generation or release of the contaminant.

(b) Properly sized and fabricated pipe or duct work attached to the hood, booth or enclosure. This duct work is used to connect the hood or hoods to the air moving equipment.

(c) A source of air movement (suction or pressure) such as a fan or exhauster connected to the opposite end of the duct work from the hood or hoods. The purpose of this equipment is to insure a flow of air through the exhaust system so that

Table 3

Type of Fuel	Btu's	Efficiency %	Available Btu/Unit of Fuel
Coal	12,000 /lb	50	6,000
Oil	142,000/gal	65	92,000
Gas	1,000/cu ft	75	750

air will enter the system through an opening in the hood and be discharged on the far side of the air mover.

(d) An air cleaning device may or may not be installed to remove the contaminant before the air is discharged outside the building. This air cleaner may be placed anywhere in the system as long as the air has passed through the hood before reaching the cleaner. Where the material is corrosive, abrasive or gummy, it is frequently advisable to clean the air prior to passing it through the fan. This, however, is not essential.

Hood Design. As pointed out above, the hood is the most difficult part of an exhaust system to design. Anyone familiar with hydraulics can lay out the air distribution system or duct work; choice of air moving equipment can satisfactorily be left to the equipment manufacturer. An attempt will be made in subsequent pages to present basic information on hood design. It is hoped such information will enable the plant engineer to determine what type of hood should be used so that adequate ventilation control can be provided for a given contaminant. This should be possible with prior knowledge only of the process and of the toxicity of the material (presented in Section 10).

There are certain fundamental principles which govern the design of a local exhaust hood. In brief, the function of a hood is:

(a) To prevent, circumvent or in some way hinder the initial motion or force of particles or gas molecules created or generated by the industrial process which is causing contamination.

(b) To utilize, wherever possible, the motion which the material might have or which has been given to it by the generating force.

(c) To cause air to flow in such a way that the contaminated portion of the atmosphere will travel away from the operator into the local exhaust system.

(d) In order to accomplish the above, the exhaust hood should be designed so that it provides a maximum of enclosure for the operation which generates the contaminant. The enclosure may be in the form of a physical structure; it may form either the sides or back of the hood itself, or be some part of the building or room structure. On the other hand, enclosure may be provided in the form of a current of air which by its motion closes some opening in the hood and thereby seals it. This will effectively prevent passage of the air-borne contaminant from within the enclosure and keep it from getting into the work space. In general, it may be said that structural material is more economical for this purpose than air. The reason for this is that the movement of air requires not only an initial investment in equipment and increased duct-work size, but also a day-by-day cost in power and in heat. It should also be pointed out that the physical structure will stop the rebounding material or any material which is projected from the process from entering the work space. The ideal hood, therefore, is one which provides complete physical enclosure of the contaminating process. Unfortunately, it is but seldom possible to design a hood for an industrial operation which provides complete physical enclosure. This is true because it is usually necessary for the worker to have access to the operation either continually or on occasion. Such access is normally made through a specifically located opening or break in the continuity of the enclosure.

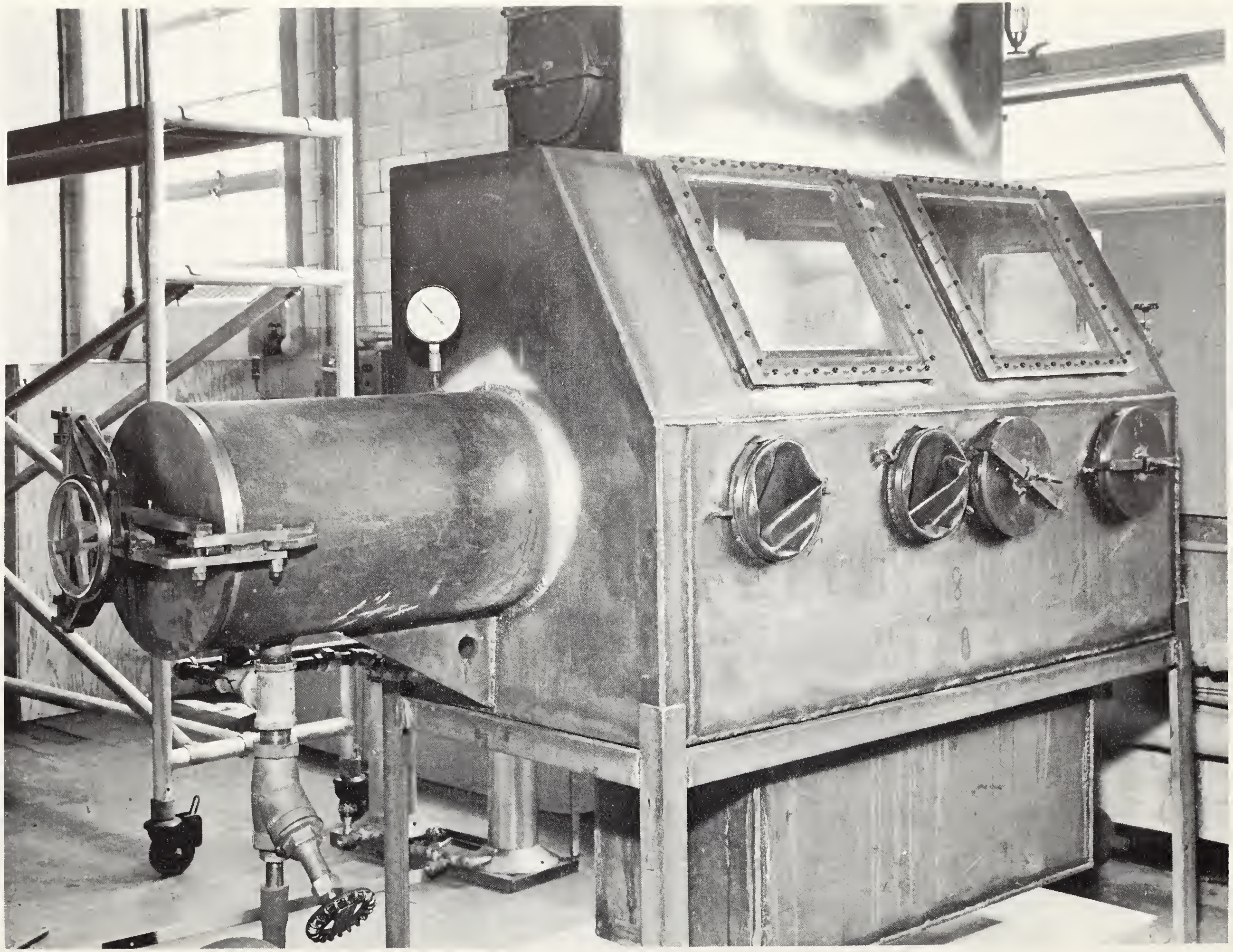


Figure 1. Dry Box

This may be a door which can be opened or shut or it may be a permanent opening. There is another factor which limits the use of complete enclosure; this has to do with the use of flammable materials. When a flammable vapor or a potentially explosive concentration of gas or vapor is apt to be generated it is necessary that an adequate amount of air flow through the enclosure so that the concentration of flammable or explosive material can be maintained at a point below that which will permit propagation of flame. In a discussion of exhaust hood design, therefore, it is useful to begin with a complete enclosure and to follow through various types of partial enclosures in order to obtain a clear picture of the design approach.

Complete Enclosure. (See Fig. 1.) Despite the fact that full enclosure is difficult for an operation, and may often be impossible, there are certain circumstances where surrounding the operation with a complete housing is sufficiently important to outweigh other considerations. These circumstances are:

(a) Where the material being handled and which might become airborne has an unusually high toxicity.

(b) When the material is generated under extreme conditions of initial projection velocity and is thrown about in random directions, as in sandblasting. Here enclosure must be provided.

(c) Where cross-contamination in chemical procedures is of unusual importance. For example, there are times when the analysis of minute quantities of chemicals, or when the production of chemicals of extremely high purity warrants the use of a complete enclosure.

(d) There are some applications where the value of the ambient air in the work space is very high. This is

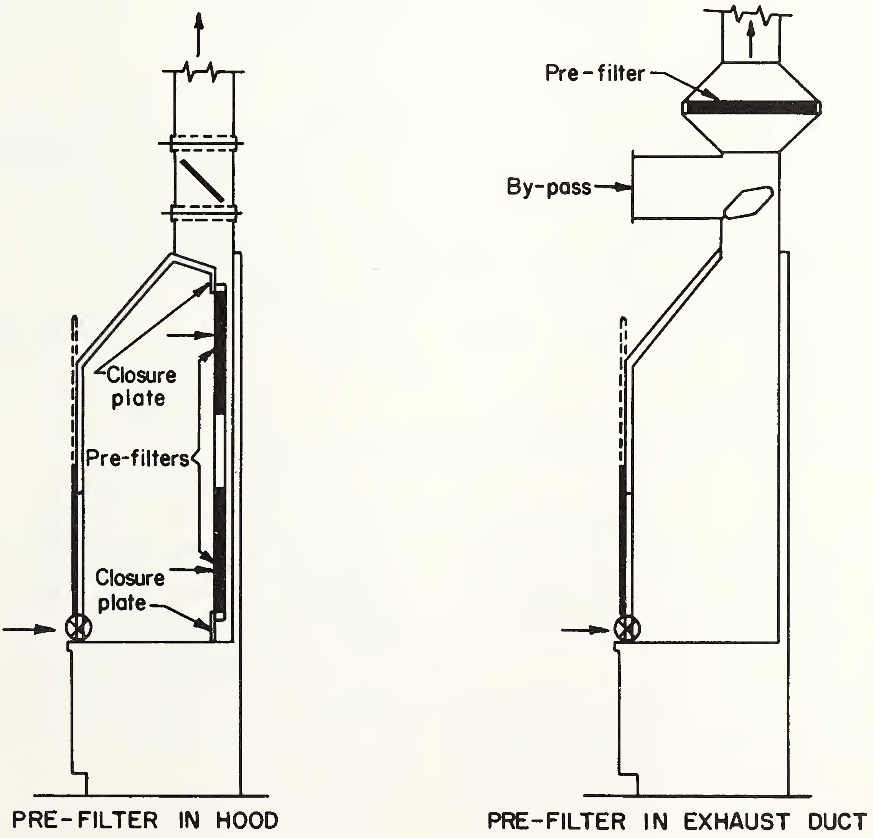
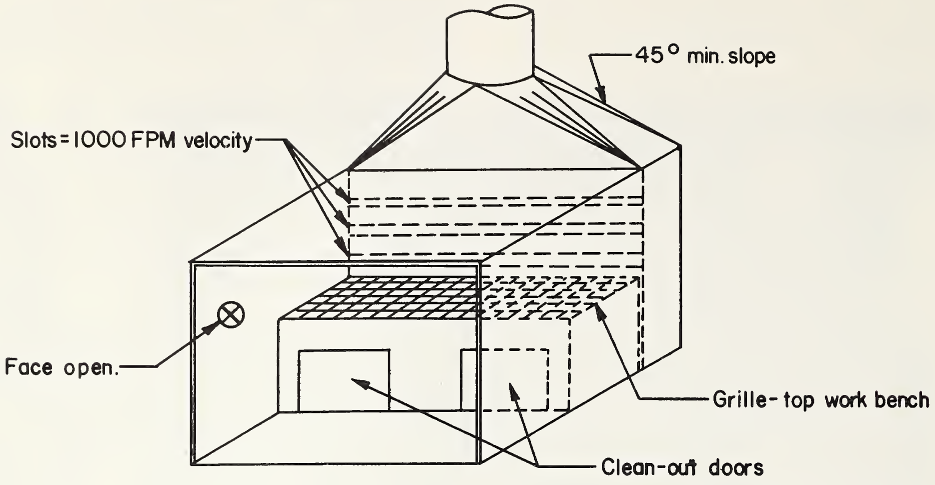


Figure 2. Chemical Hood

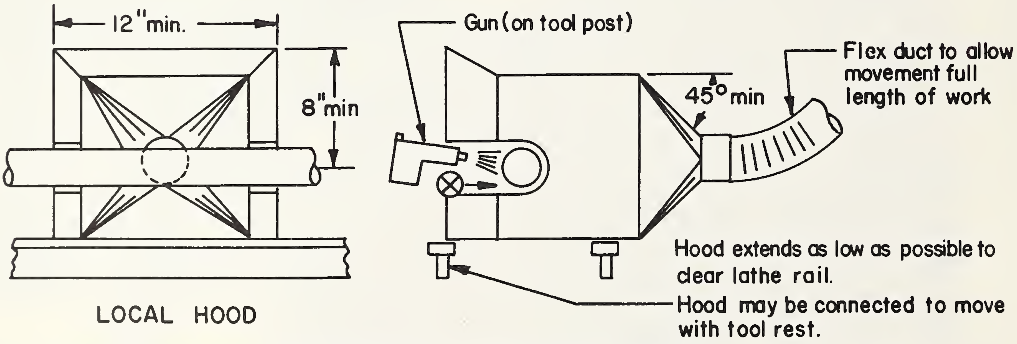


METALLIZING BOOTH

Non-toxic: Q = 125 CFM/sq.ft. face area

Toxic: Provide Bureau of Mines approved air-supplied respirator.
Q = 200 CFM/sq.ft. face area

Duct velocity = 3000 FPM min
Entry loss = 1.78 slot VP + 0.25 duct VP
Small lathe, etc., may be mounted in booth


12" min.
8" min
Gun (on tool post)
45° min
Flex duct to allow movement full length of work
Hood extends as low as possible to clear lathe rail.
Hood may be connected to move with tool rest.

LOCAL HOOD

Note: Local hood not satisfactory for spraying toxic metals.

Figure 3. Metallizing Booth Head

true where replacement air must be sent through high efficiency filters, and when a high degree of temperature control or air conditioning is required in the work space.

(e) There are certain industrial processes which require complete enclosure, such as where the operation must be maintained in an inert atmosphere or at a high or low temperature or in a vacuum.

Ventilation is generally applied to a total enclosure in a quantity merely sufficient to maintain a negative pressure on the inside. This depends on the tightness of the enclosure, its size, and the rate of evolution of material within. Sometimes when the evolution rate is high and vision is obscured the enclosure must be exhausted and the air replaced at a rate high enough to permit visibility.

Partial Enclosure. Most industrial exhaust hoods installed for the protection of employees fall into the

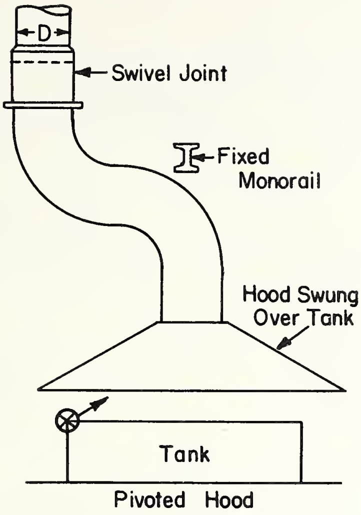


Figure 4. Canopy Hood

category of partial enclosures. In the case of a hood of this type, the work, process, or machine generating the air contaminant is located in a physical enclosure, leaving a portion of the enclosure open for normal access to the operation. The best approach in designing such a hood is to assume that the operation is fully enclosed. After drawing a complete enclosure for the machine or process, openings can be indicated wherever access is required for routine maintenance, for adjustment, or for the introduction or removal of the work. If access is required very frequently, the opening should be permanent; if only occasionally, it may be covered. If visibility is necessary without access, glass or transparent plastic observation posts may be included. Typical installations are illustrated in Figures 2 and 3.

The rate of ventilation for such a hood depends largely on the toxicity of the material. Suitable figures and calculations are presented in Tables 8, 9, 10 (pp. 51-52). It is important to apply the "control velocity" in the proper location, i.e., that point most remote from the exhaust port where the material which should be removed is being generated. Control velocity is the air velocity across the work which will effectively prevent the contaminating substance from entering the worker's breathing zone.

Non-Enclosing Hoods. The third major type of exhaust hood provides an air intake designed to move air in such a way that it completely surrounds the work and flows away from the operator. Obviously, a complete lack of enclosure is impossible in that the air intake itself provides a certain amount of closure for the operation. This, however, may be negligible from the standpoint of enclosing the work. Every effort should be made to place the air intake so that the normally existing physical structure of the machine and of the equipment in it form an extension of the hood. Examples of this type of hood are shown in Figures 4 and 5.

Tailored Hoods. There are a large number of industrial processes and a great many machines to which stylized hoods cannot be applied without

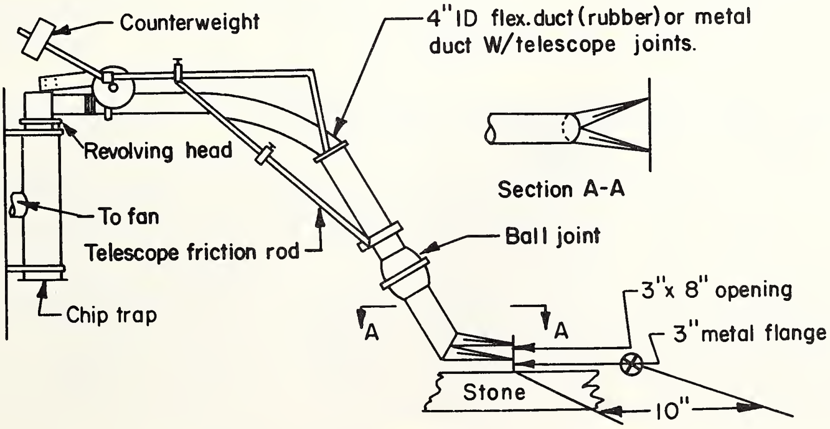
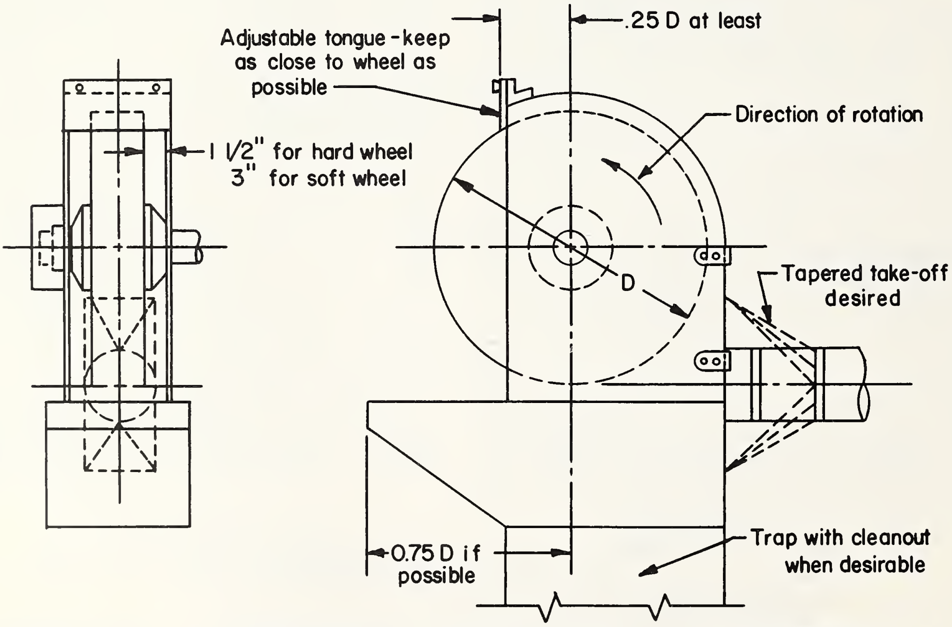


Figure 5. Banker Exhaust Hood

modification. This includes machines which have unusual types of operating procedures or unusual shapes. Such a machine in itself may not be unusual but it merely does not fit into a larger pattern of equipment. A commonly used machine which has a hood designed specifically for it is the grinding or buffing wheel. The hood serves a double function; it provides a mechanical guard against injury by contact with the spinning wheel or from explosion of the wheel, and it becomes an exhaust hood merely by drawing air through this enclosure. As can be seen in Figure 6 this hood is essentially molded to the machine permitting only operating access. This design cannot be usefully applied to any other type of machine. Because of its application to grinding, buffing, polishing, scratch brushing, and the like, and because of the insistence of safety engineers on its use, it is probably one of the most familiar exhaust units of industry.

Integral Hoods. There are a few pieces of equipment or operations which will permit incorporation of either the equipment or of a housing around the equipment or the operation as an integral part of the exhaust system. This is an unusual application but one which is very worthwhile if it can be used. The most common device of this type is the hollow trunnion rotary mill shown in Figure 7. The surface coating of large trailer or railroad car interiors is another such application. The unloading of railroad cars used for the shipment of radium ores, and which may contain high concentrations of radon gas, also makes use of this principle.



Wheel diam. inches	Wheel width inches	Exhaust volume CFM	Exhaust volume CFM
		Good enclosure	Poor enclosure
to 9	2	300	400
over 9 to 16	3	500	670
over 16 to 19	4	610	800
over 19 to 24	5	740	1100
over 24 to 30	6	1040	1400
over 30 to 36	6	1175	1800

Figure 6. Grinding Wheel Hood

Table 4. Typical Exhaust Volumes

Dust Producing Equipment	*Exhaust Hood*	*Exhaust Requirements*
Abrasive blast rooms (sand, grit or shot)	Tight enclosure w/air inlets (usually in roof)	60-100 fpm downdraft (long rooms of tunnel proportions 100 fpm cross-draft).
Abrasive blast cabinets	Tight enclosure w/access openings	20 air changes per minute but not less than 500 fpm through all openings.
Bagging machines	Booth or enclosure (provide spillage hopper)	Paper bags - 100 cfm/sq ft open area. Cloth bags - 200 cfm/sq ft open area.
Barrels (for filling or removing material)	Local hood 120 deg. around top of barrel.	Through 24 in. dia. -4 in. branch. Over 24 in. dia. -5 in. branch.
Belt conveyors	Hoods at transfer point	Belt speeds less than 200 fpm—350 cfm/ft of belt width, but not less than 150 fpm through open area. Belt speed over 200 fpm-500 cfm/ft of belt width, but not less than 200 fpm through open area.
Conveyor to conveyor	Hoods at transfer point	Same as above. See Note 1.
Chute to conveyor	Hoods at transfer point	Same as above. See Note 1. (Inspection door in chute may be required.)
Magnetic pulley	Hoods at transfer point	500 cfm/ft of belt width. See Note 1.
Shakeout conveyor	Continuous hood w/take-off max. of 30 ft apart	350 cfm/ft of belt width with air inlets every 30 ft.
Belt wipers (may be required with high speed belts)	Tight fitting hood held against under side of belt	200 cfm/ft of belt width.
Bins (closed bin top)	Connect to bin top away from feed point	150-200 fpm through open area at feed points, but not less than 0.5 cfm/cu ft of bin capacity.

Table 4. Typical Exhaust Volumes (continued)

Dust Producing Equipment	*Exhaust Hood*	*Exhaust Requirements*
Bucket elevators	Tight casing required	100 cfm/sq ft of elevator casing cross-section. (Exhaust from elevator head.) 15 to 18 in. gravity vent is also recommended when handling hot-steaming sand. (Equal volumes may be required from foot of elevator to prevent dusting due to spillage from heads.) See Note 2.
Ceramics-dry pan, dry press	Local hoods	See Mixers. Automatic feed, 1-5 in. dia. branch at die. Manual feed, 1-5 in. dia. branch at supply bin; 1-5 in. dia. branch at die.
Vibrating feeders-shakeout hopper to conveyor	Complete enclosure	500 cfm/ft of feeder width. (Provide rubber or canvas flexible seals between shakeout hopper sides and end and also feeder sides and end.)
Fettling, brushing, sagger filling and unload	Downdraft or side hood	100-150 cfm/sq ft of plan area of dust producing operation.
Floor grate	Side hood	For heavy loads of dry dust and continuous dumping or feeding operations, treat same as shakeout side hoods. See below.
	Downdraft	When used occasionally, 50-100 cfm/sq ft of grate area—depending on fineness and dryness of material.
Grinders-polishing, buffing, etc.	Standard wheel hood	See Figure 6.
Grinders-swing frame	Booth	100-150 fpm indraft through opening in booth face.

Table 4. Typical Exhaust Volumes (continued)

Dust Producing Equipment	*Exhaust Hood*	*Exhaust Requirements*
Grinders-portable and flexible shaft	Downdraft grilles. Use side shields where possible.	Bench type, 200-400 cfm/sq ft of exhaust grille but not less than 150 cfm/sq ft of plan working area. Floor grille, 200-400 cfm/sq ft of exhaust grille but not less than 100 cfm/sq ft of plan working area.
Tumbling mills-hollow trunnion type	Exhaust connection by manufacturer	Use branch dia. same size as exhaust outlet. For round mills branch dia. should be 1/6 dia. of mill; for square mills, branch dia. should be 1 in. plus 1/6 side dimension of mill.
Mixer	Enclosure	100-200 fpm through working and inspection openings.
Mold conveyors	Pouring hood	200-300 cfm/linear ft of hood w/slot velocities of 1500 fpm. Exhaust take-off every 8-10 ft. See Note 4.
	Smoke. Hood-enclosed and semi-enclosed	75-100 cfm/linear ft of hood. Dust collection equipment not required. Enclosed hood can employ exhaust takeoffs on approx. 60 ft centers. Semi-enclosed can employ exhaust takeoffs every 15-20 ft. See Note 4.
Pharmaceuticals Coating pans	Narrow side hood	Through 16 in. dia. opening—200 cfm. Over 16 in. through 22 in.—300 cfm. Over 22 in. through 26 in.—400 cfm.
Shakeouts-foundry	Enclosure	200 fpm through all openings in enclosure, but not less than 200 cfm/sq ft of grate area. See Note 5.

Table 4. Typical Exhaust Volumes (continued)

Dust Producing Equipment	*Exhaust Hood*	*Exhaust Requirements*
Shakeouts - foundry	Side hood. Use side shields whenever possible.	400-600 cfm/sq ft of shakeout grate area. See Note 5.
Apron conveyor for light flask work	None	Ventilate conveyor equivalent to 75-100 cfm/sq ft of gross grate area, assuming all grates open at any one time.
Belt conveyor for light flask nonferrous castings	None	Same as above
Shaker conveyor above floor - snap flask work	Side or overhead hood	Ventilate housing at rate of 125 to 150 cfm/sq ft gross open area. Assume all doors open at one time. Include area between housing and conveyor sides in volume determination. Usual clearance 1 in. or less on each conveyor side.
Shaker conveyor below floor - snap flask work	None	Same as above. See Note 6.
Tunnel ventilation	Enclosure	When vibrating shakeout hoppers are located in a closed tunnel, ventilate the tunnel at 100 cfm/sq ft of tunnel cross section. Exhaust from transfer points can provide all, or part of, air required. Any additional exhaust required should be taken in rear of shakeout hopper.
Screens-vibrating, flat deck	Enclosure	150-200 fpm indraft through hood openings, but not less than 25-50 cfm/sq ft of screen area.
Cylindrical	Enclosure	100 cfm/sq ft of circular cross-section but not less than 400 fpm indraft through openings in enclosure.

Notes to Table 4

1. In steel foundries where dry baked sand molds are handled, increase volumes 50% due to heavy dust loadings.
2. Gravity stack provides some ventilation in case of branch duct plugging due to steam condensation, and in case of storage bins, vents steam released when Roto-Clone is stopped at end of shift.
3. When multiple grates are employed, exhaust each grate. Blast gates to control grates in actual use have never proved practical.
4. Commercial stack fans, often exhausting two or three branches, are usual equipment for this operation. Velocities in branch and main will usually be between 1200 and 1500 cfm.
5. Venting of shakeout hoppers to relieve entrained air and prevent rebounding of dust from hopper to working or tunnel area appears to have merit. It is recommended that a portion of the shakeout exhaust volume, equal to 40 cfm/sq ft of shakeout grate, be exhausted from the hopper. Provide this branch with blast gate so connection can be closed if excessive sand is picked up.
6. Where many stations are involved and reasonable assurance exists that doors at unused stations will be closed, exhaust volume need not exceed one air change per minute for the conveyor tunnel.

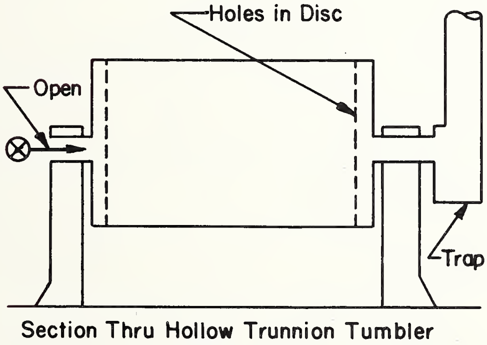


Figure 7. Hollow Trunnion Tumbler Hood

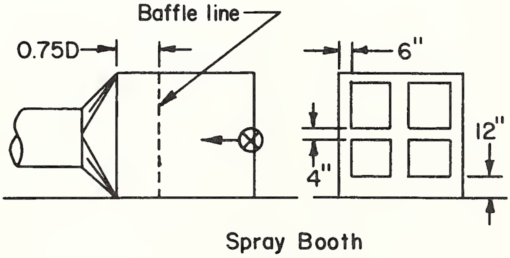


Figure 8. Spray Booth Head

Table 4 provides commonly accepted air volumes for the tailored and integral hoods just described.

Booths. Booths are among the most common devices for controlling atmospheric contamination which is industrially created. They are found in many types of shops doing a tremendous variety of operations. They range in size from very small to exceedingly large.

Broadly speaking, a booth is an enclosure with a top, a bottom, two sides, and a rear, with a fully open front. It may be mounted on a bench or table top, or may be carried right down to the floor. There are several limitations to the application of such equipment. However, where these limitations do not apply, the booth is very useful. The practical application of the booth may be said to be permissible when the following criteria are satisfied:

(a) The work must be such as to be possible of accomplishment within the confines of the booth.

(b) It must be possible for the operator to perform the work standing outside the booth.

The booth must be designed in such a way as to provide a reasonably uniform velocity of air into it from the outside, preferably through it and across the operating area.

The total quantity of air removed from the work space by the booth is determined by the area of the front of the booth. For this reason the area of the booth face should be maintained at a minimum (Figure 8). The booth is a variety of total enclosure where one side is sealed with a curtain of air. From this concept it is obvious that the control velocity should be developed across the entire face opening. Various devices such as baffles are used to insure reasonable distribution.

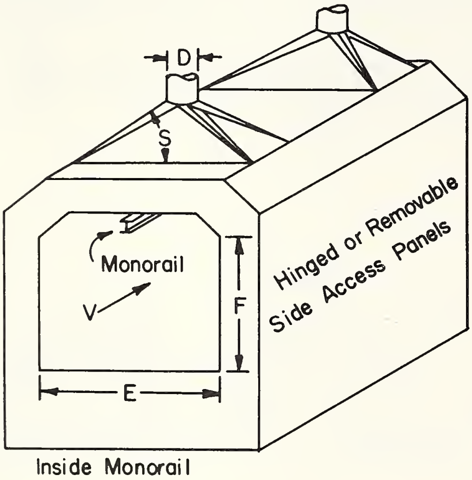


Figure 9. Tunnel Hood

Tunnels. Figure 9 shows a modification of the booth, which in reality consists of two booths placed back to back. This is normally termed a "tunnel," and is particularly useful for ventilating material volatilized or vaporized in a conveyorized operation. This type of operation is quite common in modern mass production plants, even those operating on a small scale. This principle may be applied to a unit operation rather than to a continuous conveyorized procedure. Paint dipping, degreasing, cementing and other similar operations which require evaporation of volatile solid materials after the major job has been completed, lend readily to tunnel-type ventilation. The tunnel can serve as a drying or cooling area when any special heat or other unusual condition is applied, such as air of low humidity, high heat, or infrared or high frequency treatment. At the same time it can remove the volatilized material from the workroom atmosphere. The tunnel can be very compact and when used for conveyorized work, it can be located in essentially useless space, i.e., among rafters or against a corner of the ceiling.

A tunnel can also be used for ventilation of a long-run conveyor over which covered containers of dusty materials are being passed.

Methods of Applying Exhaust Ventilations to Hoods. Whenever a hood is designed which does not totally or substantially enclose the operation, the manner in which the air is withdrawn can improve the effectiveness of the hood. Location of the air take-off point should always be carefully studied so that the air may be withdrawn in such a way that it will be assisted by the operation or the material, or the way in which the material is handled or evolved. Wherever possible the take-off point should be located close to the most important source of the contaminated material. These and other devices should be studied before determining how and where the primary air take-off should be located; in many cases two locations are preferable to one.

Obviously, the air may be exhausted to either side or it may be drawn upward, downward, or forward; it may be drawn through an extended opening, or the opening may be reduced in size. The velocity of the air may be high or low, but in any event these factors should be considered before a hood is designed. The application of these various factors will be discussed in the following paragraphs.

Updraft. This is a common type of industrial exhaust hood based on an upward current of air, especially useful where natural ventilation is employed. Hoods which utilize an upward current may be applied to hot processes. (See Figure 4). The canopy hood was undoubtedly originally developed for exhausting gases from a fireplace or kiln. It is used for exhausting steam, smoke, or just

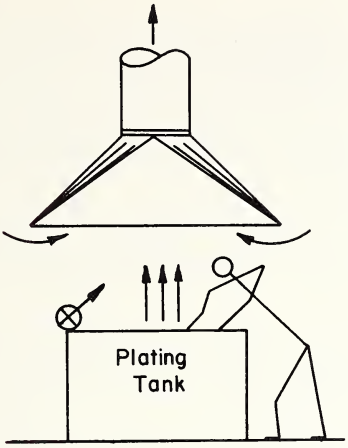


Figure 10. Updraft Type of Exhaust Hood

plain hot air from work space. Unfortunately, however, it is frequently misapplied and is used to control many types of operation for which it is not suited.

When the contaminated air generated by a process is hotter than ambient and therefore tends to rise, the cost of moving that air can be reduced by making use of this natural rise. It should be noted, however, that the usefulness of such a device is largely dependent on where the operator must perform his function (Figure 10).

Downdraft. Just as the upward projection of material by convectional forces can be converted to use in removing material from a work space through a canopy-type hood, so gravity can assist in the removal of heavy, large particulate material. A properly designed downdraft bench hood can be used to keep the operating area free of debris; to collect excess materials in a hopper, from which they may be re-used; and to maintain a low level of contamination in the work space.

Downdraft exhausting is also useful where the worker must have access to all sides of a large object. In this case there is no other direction in which the air can be exhausted without some of the contaminated material passing through the breathing zone of the operator.

Sidedraft. The most usual, and perhaps the most flexible, direction from which air can be withdrawn in order to control contaminating material is toward the side. Exhausting to the side, or lateral exhaust, can be interpreted as being located on one or all four sides permissible to an operation. Any operation which is performed on a bench, a table, a floor or other solid continuous work surface lends itself readily to application of a lateral exhaust hood. It is especially advantageous where access to the operation is desirable from the top. Many different types of hoods have been designed to produce this very desirable effect, each of which has its own special advantage and application. The fundamental considerations governing the use of lateral exhaust can briefly be summarized as follows:

(a) It is necessary to provide adequate distribution of air at a sufficient velocity to every point of the operation from which material is being generated.

(b) It is necessary that sufficient air velocity be maintained at every point of the operation to overcome any disturbing force.

(c) Ventilation should be provided by an exhaust hood which does not significantly clutter or otherwise obstruct the operating surface.

(d) All of the above criteria should be met using a minimum amount of air.

Hoods used in this manner may be fixed or movable; they may be stationed along any one side or all sides; they may be at the same level as the operation, or somewhat above or below it. In any event, the considerations mentioned above should govern both the location and the design of the exhaust opening.

Air Flow. The basic equation for the calculation of air flow is:

$$Q = AV \qquad (5)$$

where:

Q = total quantity of air, expressed in cubic feet per minute, drawn through the system.

A = the cross-section area in square feet of any section through which the air is drawn.

V = the air velocity, in linear feet per minute, which is going through the area, expressed by A.

The quantity Q is determined by the air flow-producing equipment, such as the fan or blower. If the air mover is already at hand, its characteristics automatically fix Q for any system. If the air mover has not been selected, needs of the system will determine its choice.

In applying an exhaust hood to a process, the most important area is the hood opening (A) through which air must travel. This opening is generally determined by the process and the choice of hood as described on p. 37.

V is determined by the material for which control must be provided, by the type of hood used, or by the local air conditions in the area such as cross-drafts, traffic, machine motion, etc. Tables 5, 6, 7, 8, and 9 will enable the reader to determine the value of V which may be applied to Equation (5) to determine the amount of Q necessary for the operation.

As noted on p.36 a local exhaust system is a device for removing atmospheric contamination from a work space. Obviously, however, the system itself does not remove the contamination but is the channel through which the air current travels.

As a necessary next step, therefore, we must examine the rules by which it would be possible to choose the quantity of air required to be exhausted by a given exhaust system. The material which is expected to produce the contamination provides a starting point. It should be mentioned that whereas the shape, size, materials, location, etc., of the hood are dictated by a given process the amount of air is only slightly dependent on the process and the location, but is largely dependent on the material creating the hazard.

An effort will be made in subsequent paragraphs to present data from which the quantity of air required to be exhausted by a given exhaust system, for a process using a given material, can be estimated. It should be pointed out that the choice of air quantity does not lend itself easily to specification. In general, industrial hygiene engineers examine a process and its location, test the material, take air samples, design hoods, and thus are able to estimate the quantity of air needed to control the process adequately. It is therefore with some reservation that a generalized procedure is presented. Care must be exercised in applying these criteria. Where the material is of considerable toxicity, it is important to take air samples after the installation is complete to insure that the desired control is being attained. The recommended procedure is similar to that used in the American Standard Code for Ventilation and Operation of Open Surface Tanks, #Z-9.1-1951. The first item which will define air quantity is the degree of hazard inherent in the material. This is a complex function which depends on such factors as the rate of gas, vapor, or mist evolution, the fire capacity or explosibility, and the inherent toxicity of the chemical. Table 5 gives the hazard rating.

Table 5. Hazard Rating

Toxicity	0	1	2	3	
Fire and Explosion	0	1	2	3	
Volatility	A	B	C	D	E
Section 10 Rating	0	1	2	3	

The toxicity classification is that used in Section 10, and the numbers correspond to none, slight, moderate and high. Table 6 gives the maxi-

Table 6. Toxicity Key According to Maximum Allowable Concentration

Section 10 Notation	Hazard Rating	Dusts, Fumes, Mists mg/m^3	Vapors, Gases ppm
High	3	0 - 0.250	0 - 25.0
Moderate	2	0.250 - 2.50	25.0 - 250.
Slight	1	2.50 - 25.	250. - 2500.
None	0	> 25.	>2500.

mum permissible concentrations which correspond approximately to these groups. The same group of numbers may be applied to the fire or explosion hazard. In subsequent application of these numbers it is recommended that when a material has both a significant toxicity and a significant fire or explosion hazard the higher number be chosen. It is not necessary to increase the number if both apply.

Table 7 has to do with rate of gas or mist evolution. It is loosely titled volatility, and lists the vapor pressures which would correspond approximately to each group.

Table 7. Volatility Key

(VP in mm of Hg at 20°C)

A = <0.0001
B = 0.0001 - 0.01
C = 0.01 - 1.0 (dust or fume)
D = 1.0 - 100
E = >100

Table 8 presents a cross chart from which the required ventilation category may be chosen. A material of volatility C, with a hazard rating of 3, would be in ventilation category c. These categories are specified in Table 10.

Table 9 introduces one additional parameter which has to do with the air motion likely to exist at the point for which the ventilation rate has been chosen. This air motion, again, has been rather loosely divided into four categories, depending on the degree of external activity predictable in the area. This is called local air motion and depends primarily on personnel activity in the work space, open windows or fans or other potential air moving devices in the neighborhood, and the mechanical activity of the machine or device to which the exhaust system is connected. The categories listed are:

Table 9. Local Air Motion Key

Slight = normal convection
Low = controlled manual
Medium = uncontrolled manual
Great = mechanical - centrifugal or paddle

(a) "Slight," which can be interpreted as meaning the normal convection currents which would exist in a work space having essentially no activity. These convection currents, usually of the order of 25 feet per minute, are random air motions generally created by small thermal gradients.

(b) The next category is "low." This presumes that there is some human motion in the area; the motion must be somewhat controlled and would include ordinary traffic and studied manual activity. In other words, control of the hazard involves consideration of any personnel activity in the ventilated area.

(c) The third category is "medium." This presupposes motion similar to that described in the previous category but with no control. Rapid

Table 8. Exhaust Rating

Volatility	Section 10 Rating Based on Toxicity or Fire Hazard			
	0 None	1 Low	2 Moderate	3 High
A	a	a	b	c
B	a	a	b	c
C (dust or fume)	a	a	b	c
D	a	b	c	d
E	a	b	c	d

Table 10. Ventilation Rate of Air Flow in Feet per Minute

Exhaust Rating (from Table 8)	As Modified By Local Air Motion (Table 9)			
	Slight	Low	Medium	Great
a (none)	---	---	---	---
b (normal)	50	100	150	200
c (moderate)	75	125	175	300
d (high)	100	150	200	500

traffic, uncontrolled manual motion and slow-moving equipment could produce this. Light cross-drafts would also create a similar degree of disturbance.

(d) "Great" is last and its extent of disturbance arises from rapid mechanical movement and gusty cross-drafts. It might be characterized by moving machinery generating currents with a velocity of 100 to 150 feet per minute, such as might be produced by a moving lathe chuck or paddle or a rapid conveyor system. A very high surface velocity such as that of a large rotating wheel is not defined, as the velocities generated are usually too great to be overcome by economical air motions. In such cases it is often necessary to make specific use of the motion to project the material in the direction of the hood or to introduce baffles or similar devices.

Table 10 presents the governing air velocity which should be used in a hood. This may be derived from Tables 5 through 9, or from the specifications given in Section 10. For enclosing hoods this control velocity means the minimum velocity of air entering the hood opening at any point in the plane of the opening of the enclosure. Where the hood is a non- or semi-enclosing device, control velocity means the velocity of air toward the hood or hoods measured at the point of generation of the contaminant which is most remote from any opening or openings in the hood.

Volume Computations. As has been mentioned previously, the most important criterion in the design of a local exhaust system is specification of the air velocity to be maintained at the point of contaminant generation which is aerodynamically farthest from the intake. (This means that that particle or bit of material which is generated by the process and is the most difficult for the exhaust system to remove should be removable.) This can be accomplished by assuming a velocity which will provide adequate control for the operation in question, and then design the system in such a way that this control is available at the most remote point.

An exhaust system must be designed using the final quantity of air which is to be moved by the fan as the governing criterion. It is, therefore, necessary to have a means for converting the so-called control velocity into a figure which will specify the quantity of air to be designed into the air moving equipment.

It is useful to understand the difference between exhausting air through a port and blowing air through a nozzle. Most of us are familiar with the nozzle effect of a fluid being ejected at high velocity. The familiar garden hose or fire hose provides a useful and reasonable simile to the discharge of air from a comparable jet. The exhausting of a fluid through an orifice, however, is quite different and we must understand this effect before a working knowledge of exhaust ventilation can be achieved. In Figure 11 we have a closed system in which air is drawn into an opening, pushed through a fan, and discharged from a nozzle of identical dimensions with the intake. The dashed line indicates the boundary of the 10 per cent velocity contour (i.e., the point at which the air velocity has slowed down to only $\frac{1}{10}$ of what it was at the face of the intake or discharge

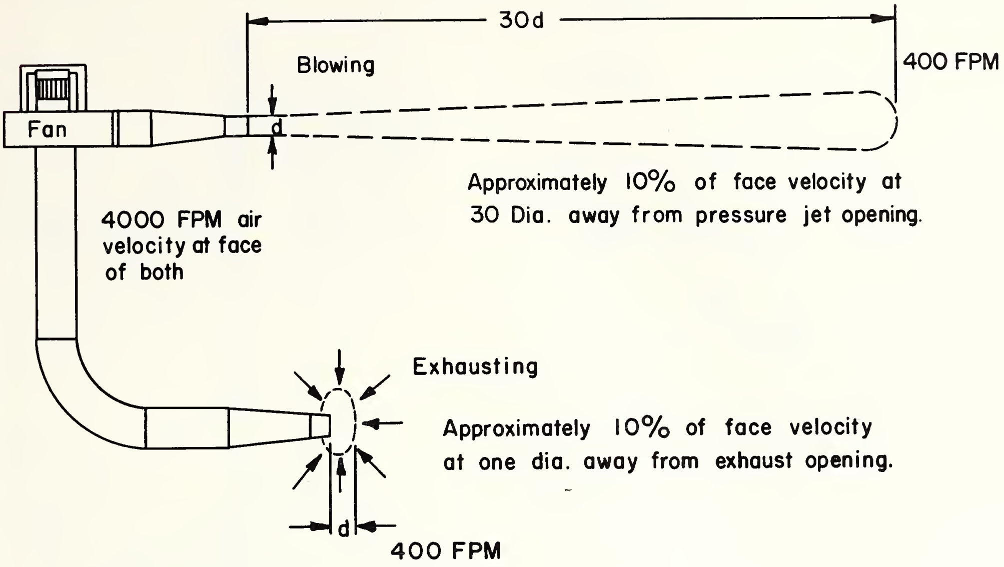

30d
Blowing
400 FPM
Fan
d
Approximately 10% of face velocity at 30 Dia. away from pressure jet opening.
4000 FPM air velocity at face of both
Exhausting
Approximately 10% of face velocity at one dia. away from exhaust opening.
d
400 FPM

Figure 11. A Closed System

nozzle). As can be seen, the 10 per cent velocity contour extends 30 diameters away from the discharge jet on the pressure side of the system, but only 1 diameter away on the intake side.

This is an important consideration. It means that the influence exerted by the air intake is felt only a short distance from the intake itself; in order for air to be effective in withdrawing a contaminant from the atmosphere at a remote location large quantities must be moved.

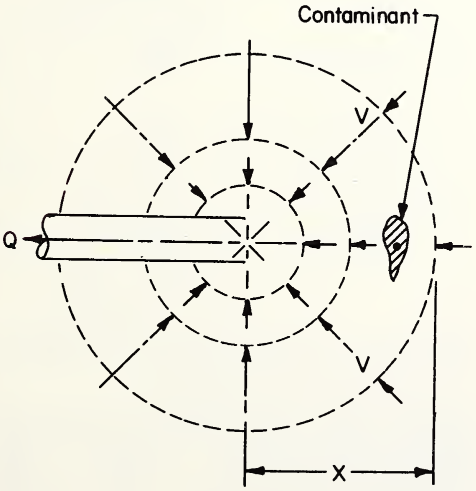


Figure 12. Theoretical Treatment of Point Source of Suction

Approaching this from a theoretical standpoint, if we could conceive of a point source of suction, that is, if the dimensions of the hood could be reduced to a single point into which air is drawn, the air would flow toward that point. Figure 12 indicates that the velocity contour has assumed a spherical shape. The parameters can be defined by the following equation:

$$V = \frac{Q}{4\pi X^2} \qquad (6)$$

where:

X = distance from point source to location of contaminant (feet)

V = required velocity at distance X (feet per minute)

Q = air volume required to create velocity at distance X (cu ft/min.)

Typical values of Q to create 100 fpm velocity:

X =	0.5 ft	1.0 ft	2.0 ft	4.0 ft
Q =	310	1260	5030	20120

These values emphasize the extreme influence distance from the suction source has upon the quantity of air. Inasmuch as the theoretical

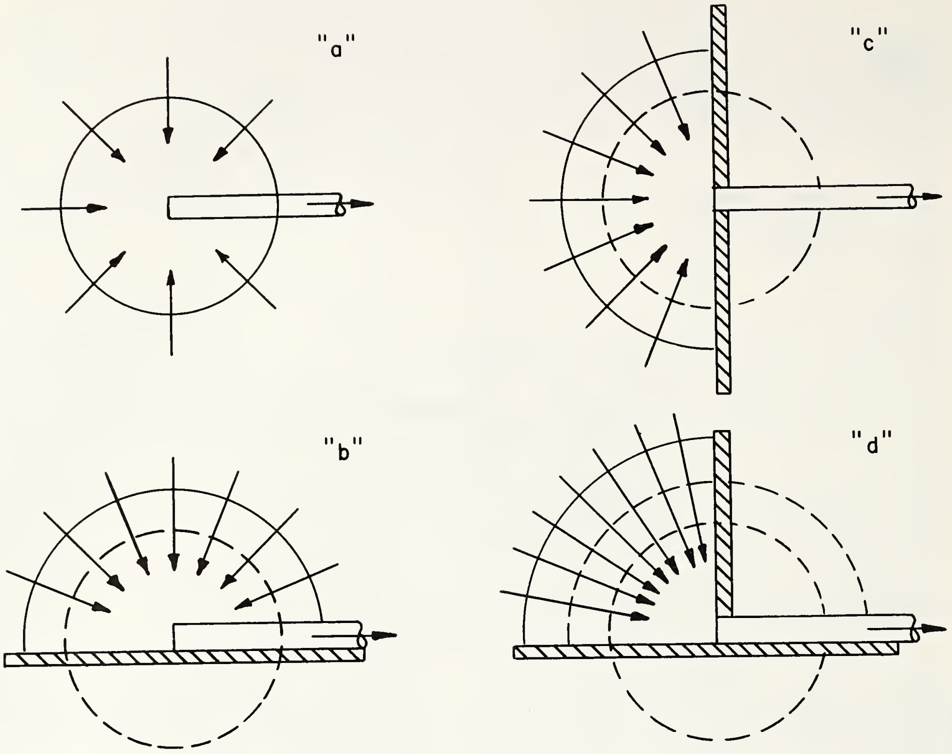


Figure 13. Duct Used as a Hood

point source of suction is never achievable in practice, it might be valuable, while keeping in mind the spherical contour, to examine practical deviation from the point source.

The first deviation from the point source is a small pipe or duct. Figure 13 shows such a duct, frequently used as a hood. The flow lines and velocity contours into this duct are shown in the Figure in "a"; "b" shows the same hood lying on a floor or table surface. Modifications of the flow lines are obvious. In many cases where a hood of this type is used, baffles are added to increase its effectiveness at the point where the contaminant originates. In "c" and "d" are shown applications of baffling. It can readily be seen that if the stray air currents induced by suction from a direction opposite the source of contaminant could be eliminated by baffling, more air would be available at the useful zone. The parameters of these situations are expressed in the following equations where all units are as expressed in Equation (6):

Case a: $$V = \frac{Q}{4\pi X^2} \tag{7}$$

Case b: $$V = \frac{2Q}{4\pi X^2} \tag{8}$$

Case c: $$V = \frac{2Q}{4\pi X^2} \tag{9}$$

Case d: $$V = \frac{4Q}{4\pi X^2} \tag{10}$$

Practical application of this type of hood is shown in Figure 5.

The next modification of a point source involves lengthening the source into a linear form. This is represented in Figure 14 as a slot. Instead of conforming to the spherical pattern, the air around such a device is substantially cylindrical, with the

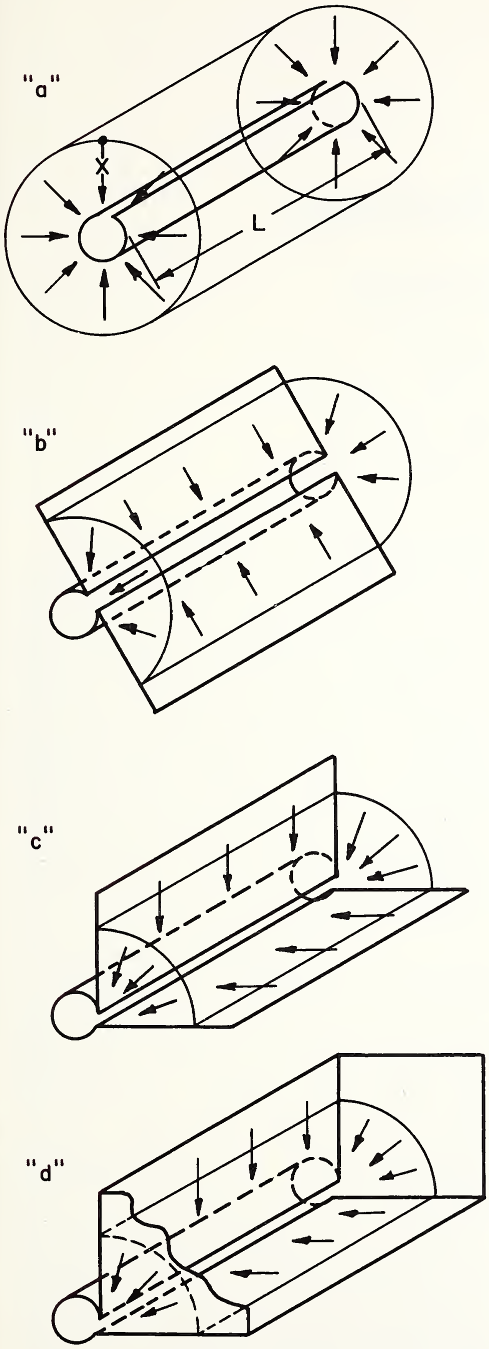


Figure 14.

exception that the two ends together form a sphere as shown in case a; case b shows the effect of adding end baffles; and case d indicates the results when the slot operates from a surface and has a full back baffle plus ends.

The equations for these forms are:

$$\text{Case a:}\quad V = \frac{Q}{2\pi XL + 4\pi X^2} \qquad (11)$$

$$\text{Case b:}\quad V = \frac{Q}{\pi XL + 2\pi X^2} \qquad (12)$$

$$\text{Case c:}\quad V = \frac{2Q}{\pi XL} \qquad (13)$$

$$\text{Case d:}\quad V = \frac{Q}{\pi XL} \qquad (14)$$

These are theoretical equations for the hoods. Empirical equations defining the difference between the theoretical velocity contours and those measured in practice have been derived by Dalla Valle, Silverman, and others. The Dalla Valle equation which holds for all types of hoods, other than long narrow slots, is

$$V = \frac{0.1\,Q}{X^2 + 0.1A} \qquad (15)$$

where

X = center line distance from the hood in feet

Q = total quantity discharged by the hood in cubic feet

V = velocity at X in feet per minute

A = hood open area in square feet

Silverman's equations are somewhat similar but cover more cases. For round unflanged hoods:

$$V = \frac{Q}{4.45\,X^2 + A}$$

for round flanged hoods:

$$V = \frac{Q}{3.1\,X^2 + A}$$

for a slot

$$\left(\frac{W}{L} = 0.2 \text{ or less}\right):$$

$$V = \frac{38.9\,Q}{XL}$$

for flanged slots

$$\left(\frac{W}{L} = 0.15 \text{ or less}\right):$$

$$V = \frac{55.4\,Q}{XL}$$

where

L = length of slot in inches

W = width of slot in inches

For Bibliography, see page 71.

SECTION 3

PERSONNEL PROTECTION and PERSONAL HYGIENE

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In rare cases, materials must be handled in such a way that it is impossible to reduce the degree of exposure. Under such circumstances, it is possible to limit the time of exposure of an individual either by rotating him with someone else or by performing the function only occasionally to keep the average exposure within acceptable limits. This type of protection has proved especially valuable in controlling radioactive exposures; in the event of disaster involving radioactivity this may be the only means by which emergency repairs can be undertaken.

Protective equipment is generally the least expensive means for control except for the substitution of an innocuous material for the more dangerous one. However, personnel protection has one serious weakness—it does nothing to reduce or to eliminate the hazard. Such equipment merely provides an immediate defense against the hazard, and is generally uncomfortable and cumbersome. It may introduce a particularly insidious hazard because such devices may suddenly become ineffective without any advance warning or knowledge on the part of the wearer. Failure will mean immediate exposure to the hazard. Because of the possible false sense of security created thereby it is the consensus of safety experts that personnel protective devices must only be regarded as emergency or temporary safeguards. Even then they should be used supplementary to suitable *preventive* measures and never in preference to them.

Respiratory Protective Devices

Respiratory protective devices provide a simple means for permitting the operator to breathe, in an otherwise toxic atmosphere, without injury. It is generally conceded that such devices should be used only in emergencies such as accidents resulting from failure of equipment or errors in operating procedures. They are also used to replace costly control devices.

It is important to use the type of respirator which is best suited to the hazard involved. The United States Bureau of Mines approval as well as manufacturers' directions describe the protection afforded. The respirator should be used only for the atmosphere described therein. For example, a dust respirator is not effective against gases, vapors or metal fumes. A respirator designed to protect against ammonia may not afford adequate protection against carbon monoxide. If the atmosphere is deficient in oxygen, or is potentially lethal, only those respirators should be used which provide a supply of clean air or which carry their own supply of oxygen.

All respiratory protective devices have two basic faults—they are uncomfortable to wear and reduce the operator's efficiency. In addition, it is difficult to secure and maintain faithful performance. If lessened ef-

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ficiency, absenteeism and labor turnover could be measured in terms of cost, the figures in many cases would probably show that the expense of eliminating a hazard is justified over the use of respirators.

To insure the effectiveness of respiratory protective devices, the U.S.B.M. tests and approves such equipment. One phase of their work is to permit the use of safe, satisfactory and reliable devices. To insure their availability, the U.S.B.M. has established schedules of minimum requirements for all types of respiratory protective equipment. Only devices approved by the U.S.B.M. should be used, as such approval constitutes authoritative proof of their effectiveness.

No matter how well a respiratory protective device is designed and made it can fail to give protection or be otherwise satisfactory unless it is properly maintained. Therefore, when the need for such devices is determined, provision should be made for their care, maintenance, and fit. Any type of respirator is uncomfortable to wear and a nuisance. Unless workmen realize fully the need of protection, they will not wear one. Important factors in getting full-employee cooperation in this respect are:

(a) Recourse to respiratory protection only as an emergency—a temporary, or a final method after every effort has been made to eliminate the hazard.

(b) Explaining the situation fully to the workmen.

(c) Careful fitting, etc.

(d) Adequate provisions for maintenance and cleanliness.

(e) Careful instruction as to use.

(f) Intelligent, fully informed supervision.

(g) A respirator once issued to a workman should be reissued to him only as long as he has need for it. Those released through labor turnover or transfers should be fully reconditioned, sterilized and returned to stock.

Respiratory protective devices fall into two broad categories:

(a) Air-purifying devices remove the contaminant from the air as it is inhaled, by filtration or by chemical sorption.

(b) Air-supplying devices supply clean respirable air or oxygen from an outside source or from a tank carried by the wearer.

Canisters. Any canister will give protection for a limited period of time, depending upon the concentration of gas, the rate of breathing, and the age of the canister. As the canister nears exhaustion, a trace of gas will leak through the mask. If this has a distinctive taste or odor or is irritating it will at least give some warning of impending failure. The all-service mask includes a timer which records the time of use and also warns the wearer, even in the case of carbon monoxide which is odorless, tasteless and nonirritating.

Canister gas masks can carry large amounts of chemicals and afford protection against a broad spectrum of poisons. They consist of a face piece, corrugated rubber connecting tube, canister and harness. The large canister permits a larger combination of chemicals, thereby affording protection against a wider range of gases. The all-service canister is designed to protect against low concentrations of all types of industrial gases, smoke and fumes. Canisters are not approved for most gases in concentrations over 2 per cent and not over 3 per cent for ammonia. Only the supplied-air type of respirator can be used for higher concentrations.

Dust respirators take dust particles out of the air by means of a filter, usually of treated paper or felt. The filter is mounted on a face piece, or half mask, covering the nose and mouth, and fits close to the face to avoid air leakage. The better respirators include a valve which opens to release exhaled air. The face piece must be so constructed as to permit sufficient adjustment to the contour of the face, and it must be lined with a resilient material for comfort. Soft cotton face piece coverings called "facelets" help to prevent skin irritations, especially for irritating dusts such as lime. The particles strained out by the filter gradually clog its pores and thus increase breathing resistance. When breathing resistance becomes uncomfortable, the filter should be changed.

Chemical cartridge respirators are similar in design to dust respirators. A cartridge (or twin cartridges) containing a suitable chemical (or chemicals) is substituted for the filter. The chemical used depends upon the gas or group of gases against which it is designed to give protection. It is important to remember that cartridge respirators carry but small amounts of chemical and are usually effective for light concentrations of gases and then only for a limited time. It is unsafe to depend upon them for concentrations of acid gases higher than 0.05 per cent and for organic vapors higher than 0.1 per cent*, indicating how entirely unsuitable they are for high concentrations.

Supplied-air respirators consist essentially of a face piece or helmet to which air is supplied through a hose or combination of hose and pipeline. The types used comprise (1) hose masks, (2) air-line respirators, and (3) oxygen-breathing apparatus.

(1) The hose mask consists of a full-mask face piece with a large diameter hose to which air is supplied by a hand-operated blower or a small power-driven blower. A sturdy harness furnishes an anchor for the hose line and for the lifeline by means of which the wearer can, if necessary, be drawn to safety from the contaminated area. Hose masks are the simplest and safest form of protector for many situations involving small areas (150 feet is the maximum permissible length of hose line). They are particularly useful for work in tanks, bins, pits, wells, and the holds of vessels, etc., but should not be used where the wearer could not reach safety if the air supply were cut off. It should be emphasized that additional protection is necessary for substances such as hydrogen cyanide which can be absorbed through the skin directly and acid vapors, for example, which can attack the skin.

(2) Air-line respirators are used with compressed air. The air line is of relatively small diameter and has a valve which controls the air flow. They are unsafe for atmospheres from which the wearer could not escape if the air supply failed. They are satisfactory for exposures of the type for which chemical cartridge or mechanical filter protection may be used. In sandblasting, metal spraying, or other operations for which complete head and neck protection is required, suitable protective helmets are worn over the mask. The fit should be tight enough in relation to the volume of air flow to prevent leakage of contaminated air into the helmet.

Care must be taken to insure a pure air supply. The area around the air-hose intake should be checked carefully for possible sources of contamination such as gasoline or diesel engine exhausts (including automobiles and trucks), smoke or gases from furnace stacks, dusts, chemical vapors, etc. Compressed air is likely to contain fumes from the oil used to lubricate the compressor valves; it may also contain dust, moisture, odors, and sometimes carbon monoxide. An air purifier is necessary to remove all these substances. Careful maintenance and operation of both compressor and purifier are vitally important. A separate motor-driven blower should be used with such a device.

(3) Oxygen-Breathing Apparatus. The wearer breathes oxygen from a high-pressure tank which he carries and is entirely independent of the outside air. His scope of action is limited only by the supply of oxygen he can carry. Both 1-hour and 2-hour sizes are available. Their principal use is for rescue and emergency repair work in mines, fighting fires in tunnels, ships, etc., entering storage tanks containing volatiles, entering sewers, gas holders, etc. Special training is necessary for their safe use.

Approval Labels

To provide purchasers and users with a means of identifying approved devices and procuring approved parts the Bureau of Mines requires that all devices marketed must have an approval label with the seal of the Bureau, the approval number, the name of the manufacturer to whom the approval is issued, and the conditions under which approval is granted. Essential parts of the devices are marked with the approval number. The markings also obligate the manufacturer to maintain the quality of the product, and to construct each device in exact accordance with the specifications approved by the Bureau. Any change in design (including any parts not in the device as approved), regardless of whether it was made by the manufacturer or the consumer, is not permissible and cannot bear the Bureau of Mines approval label.

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* 500 parts per million and 1,000 parts per million, respectively.

The approval label (metal plate) is affixed to self-contained breathing apparatus. Canister-type gas masks bear a label on the case as well as on each canister, and the approval number is marked on the face piece and canister harness, as for example "BM-1400." Type A (hose mask) and type B (special hose mask without blower) supplied-air respirators carry approval labels on the cases or containers, and the approval number on the air-supply arrangement, air-supply line, face piece, and harness. Type C (air-line respirator) and type CE (abrasive-blasting respirator) carry the approval label on the cases or on a special sheet with instructions for their use; the approval number is marked on the air-supply line, air-regulating valve, harness, and the face piece, hood, or helmet. The containers of dispersoid respirators and the replacement-filter units bear approval labels, and the approval number is marked on the face piece and each filter unit. The filter units also bear a marking that designates the type of particulate matter for which they are approved, as pneumoconiosis-producing and nuisance dusts, toxic dusts, or fumes.

Names and Addresses of Companies to Which Approvals Have Been Granted

Acme Protection Equipment Co., 3037 West Lake Street, Chicago 12, Ill.
American-LaFrance Foamite Corp., Elmira, N. Y.
American Optical Co., Southbridge, Mass.
Binks Manufacturing Co., 3114 Carroll Ave., Chicago 12, Ill.
E. D. Bullard Co., 275 Eighth St., San Francisco 3, Calif.
Chicago Eye Shield Co., 2300 Warren Boulevard, Chicago 12, Ill.
H. S. Cover, Station A, South Bend, Ind.
Davis Emergency Equipment Co., Inc., 45 Halleck St., Newark 4, N. J.
The DeVilbiss Co., Toledo, Ohio
Draegerwerk Lubeck, Germany
Hygeia Filtering Corp. (formerly the Hygeia Respirator Co.), 129 E. 8th St., N. Y. 3, N. Y.
B. F. McDonald Co., 5721 W. 96th St., Los Angeles 45, Calif.
Metallizing Engineering Co., Inc., 38-14 30th St., Long Island City 1, N. Y.
Mine Safety Appliances Co., Braddock, Thomas and Meade Sts., Pittsburgh 8, Pa.
Pangborn Corp., Hagerstown, Md.
Pulmosan Safety Equipment Corp., 644 Pacific St., Brooklyn 17, N. Y.
Scott Aviation Corp., Lancaster, N. Y.
Siebe, Gorman and Co., Ltd., London, England
W. W. Sly Manufacturing Co., 4735 Train Ave., Cleveland 2, Ohio
Standard Safety Equipment Co., 232 W. Ontario St., Chicago 10, Ill.
Willson Products, Inc., Reading, Pa.

Protective Apparel

Substances which are absorbed through the skin or which will irritate the skin require some type of clothing as a protective barrier. Such clothing must be suited to the nature of the substance, the exposure involved, and the kind of work done. It must permit of adequate movement, and be resistive to attack by the substance in question; it should not absorb it to any extent or be easily penetrated by it. The material should be cleanable and have wearing qualities consistent with the application. The garment should be as comfortable as possible, and have an attractive appearance. The latter is especially important when women workers are involved.

Protective Barriers. The most popular method for the prevention of skin irritation by a substance is the use of protective creams. These do not give the positive and lasting protection afforded by protective clothing, but this is counter-balanced by the willingness of workers to use them. In some cases clothing cannot be worn because of the degree of coverage involved. This is true where the skin of the head and neck is exposed, requiring a hood for protection, and also where a greater degree of tactile sensitivity is necessary than gloves will allow. In all of these cases, properly chosen creams may give adequate protection.

Choice Criteria. One important limitation of protective creams is that no single cream provides adequate protection against all types of material. For this reason many manufacturers make and distribute protective creams of different compositions, compounded to give optimum protection against different classes of material. The most important criterion for choosing a suitable cream is that it provide either a barrier or a detoxifying action against a particular hazard. It should not contain any irritating or sensitizing materials and the detoxifying agent should be substantially inert to the skin. To be successful a cream should be cosmetically prepared, appealing to the eye, nose and skin, and of such a consistency as to be easily applied and adherent for as long as possible. It should also be easily removed with soap and water.

Application. Before applying a protective cream, the skin should be thoroughly cleaned to remove any possible irritant. If possible, it should be applied before the start of work, washed off before lunch and reapplied after lunch, and again washed off before leaving the job. If at any time during working hours the cream becomes badly contaminated, it should be removed and reapplied.

Types. Depending upon the protection desired one of the following creams may be used.

(a) Vanishing Cream. When applied before work vanishing cream facilitates the removal of soil encountered during work and permits better cleaning of the body than would otherwise be possible.

(b) Creams which leave a thin film of resin or wax on the skin and thus prevent irritation from the toxic agent. These may be either water-soluble for protection against solvents, or water-insoluble to keep out water or water solutions of irritant materials.

(c) Protective creams which cover the skin with a harmless fat protect against water-soluble materials and offer some protection against solids.

(d) Detoxifying creams contain a nonirritating acid (e.g., boric acid or benzoic acid) to protect against alkali. A soap or magnesium hydroxide cream provides protection against acid.

(e) Creams containing inert powders (e.g., zinc oxide, bentonite, etc.,) form a more impervious coating than the waxy or greasy materials mentioned above and will prevent attack by allergens and possibly physical irritation from glass fibers, thorns, etc.

(f) Ointments containing radiation screens are used to protect against visible light, especially ultraviolet radiation. Creams containing suitable deflecting materials will protect against infrared damage to the skin.

Personal Hygiene

In discussing personal hygiene, it is necessary to consider many factors pertaining to the individual habits of an employee. In addition to his habits, it is also advisable to consider the supply, use and laundering of his clothes. The degree of personal hygiene required to prevent injury by any substance is a function not only of the nature of the substance but also of the type of hazard. A substance, for example, which is dangerous when inhaled but not at all dangerous when ingested does not require particular care in the prevention of ingestion. It is not necessary, therefore, to insist that the worker or individual handling it keep his hands clean. In a similar manner, where the hazard is primarily from ingestion or absorption, and inhalation is not considered a problem, emphasis must be placed on cleanliness and the prevention of contact rather than ventilation or other similar practices.

Hand Washing. Wherever individuals are apt to handle dangerous materials, adequate washing facilities should be provided. In determining the adequacy of such facilities the following should be considered:

(a) Ample supply of water, preferably running.

(b) Mild soap to prevent irritation.

(c) If a scrubbing agent is required in the soap, some soft material which will not abrade the skin (i. e., corn meal or other organic type scrubbers) should be used.

(d) A sanitary means should be provided for drying after washing.

All of the above items are indicated as routine good hygiene. However, where the substance is of more than minimal potential hazard, some action should be taken by supervisory personnel to insure that the facilities are used frequently. This should include washing the hands before smoking or eating and prior to leaving the area where the dangerous substance is handled.

Showers. It is a good practice to provide shower facilities in any area where dangerous materials are used. Again, this is especially true where the material may irritate the skin or be absorbed through the skin. Where the danger of such a hazard is large, showers should be encouraged; where a serious hazard exists, they should be enforced. In some industrial plants where a high degree of control over the personal hygiene of an individual is indicated, a deluge type of shower is useful. This operates continuously and is installed somewhere between the work space and the exit so that after undressing and before redressing each individual is showered whatever his desire. This system tends to encourage showering. Whenever this type of control is practiced, however, it is probably advisable to supply a clean change of clothes as well. The flooding type of shower has been used successfully in industrial plants and laboratories handling dangerous materials, as an emergency measure for cases involving acid or caustic burns, or actual fire. Inasmuch as most such materials are water-soluble, the simplest and most effective means for providing such a flood is to have an open shower head provided with a deluge valve available over a floor drain. Thus, an individual can get to the shower quickly and wash away the corrosive substance by a single pull of a quick-opening valve. This method is not as effective for hydrophobic materials (oils); these can be washed away with relatively innocuous substances such as high flash naphtha or one of the alcohols.

Clothes Change. When handling materials which are irritating, or can be absorbed, or which are unusually toxic, it is frequently desirable not to remove work clothes from the work area. In order to accomplish this, it is necessary to provide lockers for the storage of street clothes and to make provisions for the issuance of work clothes. In areas where radioactive materials are handled and in places having unusual analytical problems, it is absolutely essential that no material be taken out of the work space into any other part of the building. It is not unusual to provide double locker rooms together with a complete change of work clothes. Thus, an employee entering the so-called "hot" or contaminated area removes his street clothes and places them in a clean clothes locker, while at the same time transferring necessary personal belongings through a transfer box. He is then issued clean work clothes which he wears through the morning shift. On leaving the morning shift for lunch, the procedure is reversed—his clothes are removed and discarded. He must then pass through a waterfall into a shower room. After showering, the operator lunches in his street clothes. This procedure is repeated again in the afternoon. It must be pointed out, however, that this is an extreme example and modifications using less rigid criteria may be successfully employed.

Local Laundry. Where work clothes are supplied to prevent removal of a potentially dangerous material from the work area, thus confining exposure to the workers only, it is desirable not to have them washed by a commercial laundry. There are relatively few materials which require such a provision but it should be kept in mind whenever dangerously contaminated work clothes must be cleaned. For example, illness has been known to occur among wives of beryllium plant operators where their only contact could have been through laundering their husbands' work clothes.

Work Habits. Materials transferred from the hands to other parts of the body can increase the hazard. For example, when toxicity is based on ingestion, transfer from the hands to the mouth is hazardous. If entry is through the nose or eyes, or open wounds, manual transport may also play a part. Irritation from scratching with contaminated hands can also be a factor in producing illness. Nail biters must be instructed to keep their hands away from the mouth; scratchers should wear gloves; goggles or protective shields should be worn to protect the eyes.

Eating in the Work Area. It has been reasonably well established that considerable quantities of a highly toxic material may be introduced into the body along with food. This is likely to happen when lunch is eaten in the work area. Toxic materials may also be transferred to the mouth by chewing gum and in the application of makeup in the work space. This of course only applies when the substance has an extreme ingestion toxicity. Personal cleanliness is most important in this type of area.

Smoking in the Work Area. Smoking is also a means by which toxic materials can be transferred to the mouth. This, however, has been somewhat overrated and probably does not warrant serious consideration, except when the material in question is unusually toxic. In some cases smoking increases the danger from fire and should be restricted from that standpoint. The possibility of inhaling toxic gases or decomposition products from the burning cigaret as well as certain air-borne materials should also be considered.

Housekeeping

The virtues of maintaining a clean shop are certainly well known. When dry, dangerous materials are handled, this, of course, is more important. There are certain rules, however, which should be considered regarding the most effective means for providing a clean shop.

Dry Sweeping. If the material being handled is toxic, broom-sweeping should be avoided unless no other means is feasible. It is sometimes necessary to remove brooms from the work space in order to insure that this very simple method of cleaning is not abused. Broom-sweeping usually raises considerable dust even when accompanied by wetting.

Flooding. The application of large quantities of water sometimes provides rapid, efficient removal of toxic materials. This is especially true of the area around a hot process where fumes tend to rise necessitating a periodic cleanup of the walls, rafters, etc. It is necessary to provide adequate sewer drainage for the materials being washed down. If the agent being removed has any value, it is advisable to provide a sump from which the washings can be recovered.

Vacuuming. One of the most effective ways to remove a dangerous material from an area without creating an air-borne hazard is to use some type of vacuum cleaner. The material is thus retained in a reusable state and can be collected if it has sufficient value. However, there are dangers involved even in the use of such apparently safe equipment. If control is to be provided for an especially hazardous substance, it is important to discharge the air after separation of the toxic material outside the work space. Extreme care should also be exercised in removing the collected material from the vacuum cleaner hopper. Wherever the value of the material warrants, the dust discharge from the cleaner can be reintroduced into the process stream.

Blowing. Although blowing is one of the most dangerous methods of cleaning, it is commonly employed by the use of compressed air lines. Under no circumstances should compressed air be used for the removal of a material having even a moderate inhalation or flammability hazard. When blowing is used it is essential that the pressure of the air supply at the nozzle be reduced to less than a few psi in order to prevent lifting any solid particles which may result in serious injury to personnel.

For Bibliography, see page 71.

SECTION 4

ATMOSPHERIC POLLUTION

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Most industrial processes release varying amounts of pollution into the atmosphere. Because of the wide variability in the rate of production of such pollutants and because of the tremendous volume of the atmosphere, coupled with its behavior, the resultant contamination may or may not be a significant problem.

The atmosphere is considered polluted if one of the following conditions can be demonstrated:

(1) *Human Injury*. Such injury may vary over a wide range: from minor irritation or discomfort to death of a considerable number of people.

(2) *Property Damage.* Here, too, the potential is highly variable, ranging from the minimal of dirty windowsills or clothes to actual property destruction.

(3) *Crop Damage.* This may range from complete denuding of all vegetation in some areas, with resultant major erosion, to mere spotting of leaves or minor discoloration of plants.

The variability in atmospheric conditions, which can result in turnover of either tremendous or small volumes of air, can make a comparatively small amount of pollution produce an extreme effect, or an enormous amount of pollution create no significant problem.

The topography of certain areas is such that maximum effects can almost never be created, while the topography of other areas tends to maximize even minor pollution. Such areas as London, Los Angeles, Donora, Meuse Valley and the Columbia River Valley are particularly susceptible to severe reactions. New York City, on the other hand, with its vast sources of pollution has only a minor pollution problem. The denuding of the Copper Hill section resulted from an overwhelming burden of pollutant on the locale.

The types of material which are involved in atmospheric pollution are defined below.

The physical form and the chemical properties of these materials will largely dictate how they may be removed from a gas stream. That device which is finally selected to clean the air must have the following characteristics:

(1) It must be capable of removing the offending material.

(2) It must be able to reduce the air-borne concentration to or below satisfactory outdoor levels.

(3) It must be of such a size as to fit into the plant complex.

(4) It should be economical to install and to operate.

(5) It should not introduce any new problems such as direct employee exposure in maintenance or cleaning, or create a waste disposal situation.

In addition to chemical materials which in themselves are toxic, the most important air pollutants from an industrial standpoint are:

(1) *Products of Combustion*. Here the offending materials may be smoke, fly ash, sulfur dioxide, various oxides of nitrogen, aldehydes and ketones, ozone, and possibly other oxidants. The importance of this group of materials derives from the almost uni-

versal application of burning as a source of power and of incineration to dispose of burnable waste materials.

(2) *Smelting Processes.* Enormous volumes of gases are released in the metallurgical industry frequently bearing chemicals which depend on the type of ore or flux being processed. The greatest offenders are fluorides, hydrofluoric acid, and the oxides of sulfur.

(3) *Chemical Industry.* In general, the chemical industry releases various acidic and alkaline gases, mists, and vapors into the atmosphere as waste products.

(4) *Odor-Producing Processes.* There are many industrial processes which release offensive materials into the air, such as slaughtering cattle, cooking oils and varnishes, the paper industry which releases gaseous wastes, and oil refining where hydrogen sulfide may be a by-product.

(5) *Miscellaneous Rock and Inert Dusts.* In stone crushing, asphalt mixing, cement manufacturing, and other rock processing operations, significant quantities of inert dusty materials are discharged.

(6) *Miscellaneous.* All other industrial processes dispersing general smokes, mists, and the wide variety of irritating and toxic chemicals special to the industry, can be grouped in this category. Extreme examples of this are: beryllium dust, radioactive materials, lead dust, and such relatively innocuous materials as oil, mist, and smoke from machining operations.

The potential of a material to create atmospheric pollution depends largely on its physical characteristics. For example, gases and vapors will mix intimately with the atmosphere and be completely at the mercy of the winds. This is also true of particulate material the particles of which are less than about 10 microns in diameter. Larger particles, however, will fall to earth more rapidly and are likely to be more of a problem.

By the same token, the physical characteristics of the pollutant will dictate the means which may be employed in its elimination. The larger the sizes of the particles generated in the process are, the easier it is to separate them from the conveying air stream. Soluble materials can be more easily removed than insoluble. Liquid droplets require less careful separation than solid particles, the smaller solid particulates and gases being the most difficult to remove from a gaseous effluent.

Means which can be employed in the removal of an atmospheric pollutant must first begin with elimination or substitution. Wherever possible, it is highly desirable to substitute a material for the offending one which will not be a problem. This, of course, is only rarely possible. On the other hand, there are many cases where modification of the process itself can eliminate the pollutant. One of the most common process modifications is substitution of oil for coal-burning where the method of firing bears an important relationship to the amount of pollutant released from the stack.

Presuming that the process is such that elimination of the contaminant through process modification or by substitution of a less bothersome material is not possible, some means must be devised to reduce the concentration at the ground. The concentration of material at a point P on the ground due to emission from a stack can be expressed as follows:

$$P_x = \frac{2\,Q}{C\,\bar{u}\,X^{\frac{(2-\mu)}{2}}\,\pi^{1/2}}\; e^{\left(-\frac{h^2}{C^2\,X^{(2-\mu)}}\right)}$$

where:

P_x = Concentration of material emitted at a point downwind of the source

Q = Source strength (grams, curies, etc.)

C = Generalized diffusion coefficients (meters $^{\mu/2}$)

$\bar{u}$ = mean wind speed (meters per second)

X = downwind coordinate (meters)

μ = nondimensional parameter associated with stability (usually taken as 0.25)

e = base of natural logarithms (2.7183)

h = height of stack or source (meters)

And the maximum ground level concentration can be expressed by:

$$P_{max} = \frac{2Q}{e\pi \bar{u} h^2}$$

From the above equations, it can be seen that the maximum concentration which exists at the ground varies inversely as the square of the stack height, and directly as the quantity of material which is ejected from the stack. It becomes obvious therefore that two procedures can be employed in reducing contamination at ground level. One procedure is to increase the height of the stack and the other one to reduce the amount of material discharged through the stack.

The economics of increasing stack height can be rather simply defined. If the ground level concentration outside of the plant is known, and the desired level may be estimated, the economics of installing cleaning equipment to obtain this level can be balanced against the cost of increasing the height of the effluent stack.

In most situations where air pollution is a serious problem, the obvious solution is to remove the pollutant before the gas is discharged. The choice of equipment will depend on several factors.

(1) The physical state of the material (i.e., solubility, liquid, solid or gas, and if particulate, the size of the particles).

(2) The value of the material.

(3) The quantity discharged.

(4) The economics of the process.

(5) The degree of cleaning required.

Within the framework of the above characteristics, an effort will be made in subsequent paragraphs to describe the various types of air cleaning equipment available and to give some indication of their areas of economic usefulness.

Commercial air cleaning equipment falls into the following categories:

(1) *Gravity Settling Devices.* The gravity settling device or settling chamber is probably the least complex of all air cleaning devices. It is simply a large box-like container with or without interior trays through which the air to be cleaned passes horizontally. These devices will handle high concentrations of dust and can successfully remove most of the particles larger than about 50 microns. The principle of the operation is that in the time it takes for the dust particle to travel from one end of the chamber to the other the action of gravity will cause it to fall in a trajectory which is intercepted by the floor. It is obvious that breaking the distance of fall by the interposition of trays in effect cuts the required effective length.

Theoretically, the full efficiency of the settling chamber is rarely reached because of turbulent air currents within the devices. In general, this type of equipment is the least expensive provided that ample room is available for its installation.

(2) *Centrifugal Separator.* The centrifugal collector operates on the principle that when a high centrifugal force is applied to an air stream containing dust, the dust will tend to migrate farther from the center than the main body of air. This principle can then be used to separate the concentrated portion of the stream and thereby remove the dust.

The simplest centrifugal collector is the cyclone which generally consists of a cylindrical section of sheet metal approximately twice as high as the diameter. Beneath the cylinder section is an inverted conical section of approximately the same length, narrowing down to about one-fourth of the cylinder diameter. The air enters tangentially at the top of the cylinder through a flattened section of inlet duct and leaves by a circular pipe emerging from the top of the otherwise closed unit.

After entering the cylinder, the air is forced by a pressure differential across the unit to whirl rapidly toward the bottom. The decreasing diameter of the conical section causes a large increase in the air velocity thereby projecting dust particles to the still layer of air along the metal. Here they slow down and gradually work their way out the bottom of the cone while the air continues to whirl up through the center and out.

In general, the efficiency of a cyclone depends on:

(a) *The apparent diameter of the particle.* This type of equipment cannot be expected to remove a significant fraction of dust particles below 1 micron in diameter. If properly designed, however, dust-containing particles above 5 microns can be removed fairly efficiently. A very high degree of efficiency can be expected when the particle size is above 20 microns.

(b) *The length of the conical section (in larger cyclones).* It has been found that lengthening the cone of a large cyclone to three or four times the diameter of the cylinder increases its efficiency. For example, in the operation of a woodworking shop, a cyclone with a conical section half the length of the cylinder will remove nothing but shavings. With a cone length equal to the length of the cylinder, most sawdust will be removed as well as chips and shavings from other processes. When the length of the cone exceeds the length of the cylinder by 50 to 100 per cent, the collector becomes quite efficient in removing sander dust.

Of course, the above is an oversimplification and there are other design factors which enter into the picture, but basically this will be found to be the case.

(c) *The pressure drop through the unit.* Although the addition of baffles, skimmers and other hindrances to the air flow tend to improve efficiency they also increase pressure drop. By the same token, and almost in direct proportion, a decrease in collector size or an increase in velocity through the collector will improve its operating characteristics.

(d) *The diameter of the cyclone cylinder.* Commercial cyclones generally fall into the following categories: (1) Large: generally greater than 36 inches in cylinder diameter; useful in removing coarse and fiberous materials. (2) Medium: generally 8 to 24 inches in diameter; operate at a moderately high pressure drop (2 to 4 inches); fairly efficient in removing sub-sieve sizes of dust. (3) Small: generally from 2 to 4 inches in diameter; operate at about a 4 inch pressure drop, and will remove between 50 and 90 per cent by weight of particles in the 5 to 10 micron range.

(e) *Dust loading.* A cyclone usually operates better under high dust loadings (i. e., a larger percentage of the material will be removed when more material is carried by the air stream).

The cost of cyclone collectors varies widely, although they are the least expensive of the air cleaners, with the exception of the settling chamber. The cost depends on the size and will run from 10¢ to 25¢ per cfm of capacity.

In addition to the cyclone, there are other devices which use the centrifugal or inertial principle for removal of dust from air streams. Each of these has certain specialized features which would be recommended over a cyclone where application is quite similar. These include the Aerodyne cone and the Type D Rotoclone.

(3) *Wet Collector.* There is a large variety of air washers, each having characteristics which make it more desirable for certain applications than the next. Basically, an air washer is a device which causes the suspended material in the air to become wetted and thereby removed from the stream. Soluble gases and particulates are most effectively removed by equipment of this type although insoluble particulates can also be handled with reasonable efficiency. The efficiency of a wet collector depends largely on the amount of power which must be used. Such collectors as the Venturi scrubber which operates in the neighborhood of 25 inches of water can remove up to 99.9 per cent of sulfuric acid mist at loadings as high as 5 grains per cubic foot. The efficiency of this equipment for the removal of particulate fume, although good, will be significantly lower, being of the order of 90 per cent to 99 per cent.

Most wet collectors, on the other hand, operate with much lower pressures. The usual reading of a wet scrubber, operating satisfactorily, is more like 2 to 6 inches of water. Here again, efficiencies are more like 90 per cent.

Devices which have been used to increase the liquid surface in a wet collector are: wetted fiber beds; wetted spheres, saddles or rings, bubble caps; high, medium and low-pressure spray nozzles, and various types of self-generating sprays created by causing the air to pass underneath a baffle immersed in liquid.

Each of these have different advantages as to method of disposal, space requirements, cost, etc., but in general, they will remove industrial dust at efficiencies of from 85 to 95 per cent.

The cost of this equipment varies depending on the type of service. Corrosion-resistant materials are a primary factor in raising the cost. Ordinary black iron equipment runs from 25¢ to $1.00 per cfm installed, with extremes as high as $10.00. The cost of water replacement and pumping must always be figured as part of the operating expense. Although this is not necessarily a tremendous part of the over-all operating cost, it may be significant in some cases.

(4) *Fiber Filters.* In general, these are divided into two broad categories—disposable or unit filters and fixed or cleanable filters; each of these is further sub-divided into at least two divisions.

(a) *Disposable or Renewable Filters.* The most common type of disposable filter is the inexpensive low-efficiency fibrous unit normally used for precleaning or for removing atmospheric dust from an air conditioning system. These units will remove most large particles and in general will remove between 25 and 50 per cent of all particles from the air. The filter medium may be anything fibrous, such as steel wool, fiber glass, rock wool pads, plastic fibers, or expanded metal. They are generally coated with some sort of viscous material although this is not essential to their operation. Filters of this type are used until they are sufficiently "plugged," to cause an increase in resistance to air flow. At this point they are removed from the system and discarded. These filters will operate with about 200 to 500 cfm per square foot and have a pressure drop of about 0.2 or 0.3 inch. As soon as the pressure drop rises to about 0.5 inch the unit is discarded or cleaned and retreated. The installed units cost from about $3.00 up to as much as $150.00 for an automatic self-cleaning installation, although the maximum non-automatic unit will run about $30.00 per 1000 cfm. Replacement or renewal of this equipment will run from about $1.00 per 1000 cfm to between $5.00 and $10.00 per 1000 cfm.

Another type of disposable or renewable filter unit is the so-called "high-efficiency filter," developed primarily by the Atomic Energy Commission and the Army Chemical Service during World War II. The purpose of these filters has been to provide essentially perfect air cleaning with cost a secondary factor. They will operate on very low dust loadings at efficiencies better than 99.99 per cent. Because they are never cleaned, the efficiency tends to improve somewhat with life. Operating filters of this type at high dust loadings (about 10 grains per 1000 cubic foot of air) is uneconomical, inasmuch as replacement costs will run between $50 to $100 per unit while the installation may cost several dollars per cfm. This equipment has the advantage of serving as a container for the material that is collected and can be disposed of as one complete unit.

These filters are made from various types of paper, usually containing very fine fibers. Cellulose fibers are generally used as the base and very fine glass fiber or asbestos fiber is distributed in the paper mix. Recently, papers have been made completely from synthetic fibers and glass fibers. The glass materials have the advantage of being resistant to both chemicals and heat.

Where similar high efficiencies are required with relatively larger dust loads, it is frequently satisfactory to fabricate a filter by building up thick pads of fine fiber glass or rock or slag wool. In fact, a thick pad of any fibrous material will effectively remove particulate material from the air to almost any desired efficiency. If a satisfactory means could be devised for getting rid of the contaminated fibers, this would be an inexpensive, efficient method for removing contaminating materials from the air. Filters of this type generally operate at an initial resistance of between $^3/_4$ and 1 inch.

(b) *Fixed or Cleanable Filters.* In general, filters of this type, frequently known as "bag houses," are the most economical and most efficient means for reducing heavy dust loads of any type at high rates of efficiency. A properly constructed cloth filter will operate continuously, removing better than 99 per cent of the dust load which enters the equipment.

There are two general types of cleanable cloth arresters characterized by the method of cleaning. One of these resorts to shaking the cloth and the other utilizes a reverse flow of air. In either case, satisfactory operation is achieved when the filter medium after cleaning has a resistance which is approximately constant. The usual range of resistance is from 3 to 6 inches of water.

The shaken bags most generally use a napped cotton sateen cloth and are designed with cloth formed into tubes which are held top and bottom. The dust-laden air enters the bottom of the tube, passes through the tube, and deposits the dust on the interior. At the end of the cycle (generally 4 hours), the equipment must be shut down, the upper hanger is released and the bag is shaken vigorously, dropping the dust into a hopper at the bottom. In some cases, the cloth is not formed into stockings but rather is stretched over wire envelopes forming a screen. The principle of operation, however, is the same. Such filters usually cost between 20¢ and 50¢ per cfm depending on size and service. The maintenance cost, if operated satisfactorily, is low. The acceptable dust loadings will generally run from 0.1 to 10 grains per cubic foot. The usual size is based on between 1 and 4 cfm per square foot of cloth.

The cleaners which use the reverse-air flow principle are similar in design to the ones discussed above. However, the most common air cleaner is the so-called "reverse jet" cleaner which is based on the Hersey patents. This cleaner uses a high velocity air jet to pierce the dust cake and thereby remove it from the dirty side of the filter medium. The jet action is accomplished by drawing a narrow slot over the filter medium. The most satisfactory means for accomplishing this has been to interlock the transport mechanism of the jet electrically to the pressure drop across the filter and thereby maintain the filter resistance fixed within narrow limits. This permits maximum filtration efficiency by allowing the greatest portion of the medium to be covered by filter cake. The usual medium is a felted cloth made from wool although synthetic fibers can be used. When high efficiency is desired, treatment of the wool by means of resins has proved effective. The general resistance range of such equipment is in the neighborhood of 3 to 5 inches and it can be regulated to plus or minus $\frac{1}{4}$ inch. The advantage of such regulation is that it permits a uniform flow through the system. The initial installed cost ranges from $1.00 per cfm but may be higher depending on the service.

(5) *Electrostatic Precipitator.* The electrostatic precipitator is usually one of two types, depending primarily on the dust load. The low-voltage type which operates at about 15,000 to 20,000 volts is satisfactory for low-dust loads in the range of grains per 1000 cubic feet. The higher voltage units operating from 40,000 to 70,000 volts will take heavier industrial loads. The main advantage of electrostatic equipment is its very low resistance. Such equipment is generally built with internal resistances to air flow of less than $\frac{1}{2}$ inch. The normal operating efficiency is in the order of 85 to 95 per cent for low-voltage equipment; for high-voltage equipment it is generally upward of 90 per cent with efficiencies of 99 per cent possible. The cost of electrostatic precipitators will generally run from $1.00 to $10.00 per cfm, depending on the size and service, although for low efficiency, costs as low as 50¢ per cfm are not unusual. Electrostatic precipitators have been successfully applied to wet aerosols and can be designed to collect such things as acid mists. A great advantage of this type of equipment is that it can handle high-temperature gases without fear of breakdown. One serious disadvantage of the electrostatic precipitator is that it suffers from occasional arcing and power fluctuation either of which effects may tend to reduce its efficiency substantially. This can be overcome by backing up the unit with an efficient fiber pack such as glass, wool, or paper. In this case, the

load on the back-up filter can be kept low enough to permit a very long life.

(6) *Miscellaneous.* For the control of organic vapors or odors, it is possible to employ adsorbent material or incineration. Silica gel or carbon beds have been effectively used for the removal of organic vapors or odorous materials. The use of catalytic combustion or direct flame combustion sometimes proves effective for this type of air cleaning, although the economics must be carefully evaluated.

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SECTION 5

RADIATION HAZARDS

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Introduction

The considerable publicity given to all matters relating to atomic energy has brought about a great increase in public interest in the possible hazards from radiation. The rapid growth of x-ray and isotope utilization means that a sizable fraction of the population is now being exposed to radiation. While there is a general awareness of the possible hazards from radiation, not all installations working with radiation are using suitable protective methods.

Radiation protection is the prevention of illness or injury from overexposure to x-rays and nuclear radiation. Radiation is usually invisible and, except in the case of acute overexposure such as might occur in an atomic explosion, the effects do not appear for some time. In the case of radium poisoning, for example, delayed effects are still being discovered as a result of exposures incurred 30 years ago. At the present time, there is no cure for the various effects produced, so all our efforts must be concentrated on prevention.

To operate a plant or a laboratory safely where x-rays or isotopes are used, it is necessary to have a general understanding of the nature of radiation, its measurement and the possible effects of overexposure. On the basis of this knowledge, methods of radiation evaluation and control may be set up.

When we consider radiation exposure, we must think of that radiation which is in addition to the normal background radiation to which man has been exposed for generations. This background radiation which comes from the naturally occurring radioisotopes and from cosmic rays is the basic level of exposure and cannot be reduced.

The experience of radiologists, radiographers and isotope users does provide a reasonable basis for adopting a program for personnel protection. This experience has resulted in the adoption of a series of maximum permissible levels for external radiation, for inhalation or ingestion of isotopes, and for laboratory or plant waste products disposal. The accepted levels contain a reasonable factor of safety. However, needless exposure to any potential hazard is foolish and every effort should be made to minimize such exposure.

The theoretical ideal of radiation control is maintenance of the exposure at background level; but this is often not possible. Economic considerations become increasingly important as the reduction in exposure is continued to lower and lower levels. The maximum permissible levels given are safe based on past experience, but designing for exposure at just these levels is not necessarily a guarantee of good radiation protection. Frequently, by careful planning, exposures can be reduced very considerably below the permissible level without extensive changes in facilities or without additional costs. In such cases, these reductions should be made. If further reduction of radiation levels requires large changes in equipment or would be very expensive, there must be a compromise between the desired and the practical levels.

Fortunately, the same physical

processes which cause radiation damage can be used to evaluate radiation exposure. Exposures can be measured and can be controlled so that permissible levels are not exceeded, and thus preventable damage from radiation can be avoided.

A radiation protection program must consist of two parts—evaluation and control. Evaluation furnishes a basis for sound control. It is seldom possible, either physically or economically, to completely eliminate exposure to radiation above background for every worker. A good control program minimizes *necessary* exposures and eliminates *needless* exposures. A continuing evaluation program will indicate the effectiveness of the controls and will give a continuous record of all exposures. This section will emphasize these two facets of a realistic radiation protection program.

Nature of Radiation

Radiation is a form of energy, and as such, can be put to use for a variety of purposes. As with other forms of energy, it can be dangerous when uncontrolled. To control radiation intelligently, it is necessary to understand its nature and then proceed to the practical aspects of measurement, evaluation and control.

In the broad sense, radiation includes light, radio waves, cosmic rays and many other forms, but our immediate interest is limited to nuclear radiation and to x-rays. These two forms represent controllable industrial or laboratory hazards that are utilized for the very properties that make them dangerous.

The fundamental properties of radiation concern mass, electrical charge and energy. While all the types of radiation that we are interested in have energies within a rather narrow range, they differ markedly in the properties of mass and charge. The radiations all originate within the atom, and their similarities and differences are characteristic of their origin.

Atomic Structure. The scientists' picture of the structure of matter has changed radically in the last century. Knowledge has progressed from the atom as an indivisible unit of a chemical element, through the planetary atom consisting of a dense central nucleus surrounded by electrons moving in orbits around it, to the modern quantum theory. The latter theory is invaluable in theoretical physics for describing the behavior of atoms, but has almost completely eliminated any simple physical picture of atomic structure. For the moment, however, we may consider the atom as a positively charged nucleus surrounded by a negatively charged electron cloud.

For many years, each chemical element was considered to have a particular atomic mass, known as its atomic weight, which was characteristic of that element. These atomic weights were used in calculating the proportions of various substances entering the chemical reactions and were considered to be among the most basic physical properties of atoms.

In studying atomic structure, however, it became apparent that the atomic weights did not have as great a regularity as might have been expected. Actually the irregular nature of the atomic weights of the elements stems from the fact that most of the elements consist of mixtures of atoms having different atomic weights. The range of these differences is small, being only one to a few atomic mass units on each side of the average atomic weight. The individual atoms of an element having a particular atomic weight make up an isotope of the element. The naturally occurring mixture of the various isotopes produces the average atomic weight, which is the one used for chemical calculations.

We can describe the properties of the atoms, their components and their radiations in physical units; the mass in atomic mass units (amu) which are $^1/_{16}$ the mass of the most abundant isotope of oxygen, the charge in units of the charge on a single electron, and the energy in terms of the energy acquired by an electron when it is accelerated by a potential of 1 volt. This latter quantity, the electron-volt (ev) is so small that we commonly speak of thousands (kev) or millions (mev) of electron volts. The absolute energy of an atom or its components is of little interest, but the energy changes involved in the production of radiation are of primary interest to us.

Within the nucleus are protons with a mass of 1 amu and a positive charge of 1 unit, and neutrons with a mass of 1 amu and no electrical charge. Outside the nucleus are electrons (extra-nuclear electrons) with a mass of about 1/1600 amu and a negative charge of one unit. The characteristics of an atom are due to the number of protons and neutrons which make it up. Since the atom is electrically neutral, the number of positively charged protons and negatively charged electrons must be equal.

The number of protons in the nucleus determines the particular species or element that the atom belongs to, while its mass is determined by the number of protons and neutrons in the nucleus. We may completely describe any atom in terms of its mass and its elemental species.

The different species are designated by the element symbol or by the atomic number (the number of protons in the nucleus) or by both. In the scientific shorthand used, ${}_6C^{12}$ describes an atom of carbon with an atomic number of 6 and a mass of 12. A different atomic number indicates a different element, but isotopes of the same element can have different masses. Our example, carbon, exists as three isotopes of mass 12, 13, and 14. These would be represented as ${}_6C^{12}$, ${}_6C^{13}$, and ${}_6C^{14}$, respectively.

Actually, since the element symbol also designates the atomic number, the more usual terminology is C^{12}, C^{13}, C^{14}, or C-12, C-13 and C-14.

The chemical nature of an element is almost independent of the particular isotope, so in a chemical reaction all of the isotopes follow the same reaction pattern. Even the isotopes of hydrogen, where the ratio of masses are 1, 2 and 3, show only slight differences in chemical reactivity. In cases of heavier elements where the relative differences in mass between isotopes is smaller, variations in chemical behavior can usually not be observed. If it is necessary to separate the isotopes of an element, physical properties highly dependent on mass must be used. Some of these which have proved practicable are the deflection of ions in a magnetic field, variations in diffusion rate of gases, and thermal diffusion. Isotopes separated in this way can hardly be distinguished chemically but may be distinguished by instruments in which measurement is based upon mass, such as, for example, the mass spectrograph or the optical spectrograph.

Approximately 270 stable isotopes of the elements are now known. The total number of isotopes has been increased by the production of artificially radioactive isotopes by particle accelerators and by atomic fission. (The general term applied to a stable or unstable isotope is nuclide.) Up to the year 1954, about 500 unstable nuclides had been identified. This means that on the average, seven to eight isotopes exist for each of the known elements.

A large fraction of the naturally existing isotopes are stable, but some of the natural isotopes and most of the man-made isotopes disintegrate spontaneously. The process of disintegration produces nuclear radiation, and the emitting isotopes are called radioisotopes. The most common emissions are alpha, beta and gamma radiation. Each type will be discussed, together with the nuclear transformation which accompanies it.

Nuclear Radiation. The radiations with which we are concerned are x-rays and the alpha, beta and gamma emissions from radioactive isotopes. There are installations where exposure to neutrons or accelerator-produced particles is possible. These should also be under competent safety supervision, but such a discussion is outside the scope of this section.

X-rays and gamma radiation are electromagnetic, that is, their properties are similar to ultraviolet rays or visible light, only it so happens that they are much more penetrating. Beta- and alpha-radiations are particulate; they are extremely small particles moving at high velocity. Since the properties of the various radiations determine not only the protective measures needed, but methods of measurements, a brief general description of radiation and the different individual radiations will be given at this point.

All types of radiation share the property of losing their energy by absorption in passing through matter. In any given case the degree of absorption depends upon the type of radiation, but all types are absorbed to some extent. Also, the process of absorption in all cases results in ionization, that is, the removal of an extra-nuclear electron from an atom of the absorbing material. It is this process of ionization that both produces damage in tissue and allows us to design instruments for its detection and measurement.

Alpha particles are emitted by many of the heavy, naturally radioactive elements. The alpha particle is the same as the nucleus of the helium atom, with a mass of 4 amu and a positive charge of 2. A typical alpha decay could be expressed,

$$_{90}Ra^{226} \longrightarrow {}_{2}He^{4} + {}_{88}Rn^{222}$$

where radium is transformed to radon by alpha emission. The relatively high mass of the alpha particle means that for a given energy, the velocity is relatively low. The exact relationship is shown by the kinetic energy relationship for mass and velocity,

$$E = \frac{1}{2} mv^2,$$

where

E = kinetic energy
m = mass
v = velocity

The heavy, slow-moving alpha particle has a great opportunity to interact with an absorber. Thus, on the average it dissipates its energy in a short path length (e.g., most alpha particles are completely absorbed by a few centimeters of air, or less than 0.005 mm of aluminum). When all its kinetic energy has been lost, the alpha particle will take up two electrons from its surroundings and become an electrically neutral, gaseous atom of helium. The energies of alphas given off by different emitters lie in the range of 4 to 8 mev but all the particles emitted from a single isotope will have the same energy.

Beta emission is a property of both heavy and light radioactive elements. The beta particle is an electron that possesses kinetic energy because of the speed with which it is emitted from the nucleus. In representing a beta emission, the change in mass of the atom is negligible, but the loss of the unit charge causes a change in atomic number, for example,

$$_{6}C^{14} \longrightarrow e + {}_{7}N^{14}$$

The energies of the beta particles given off by a single emitting isotope cover a range of from 0 mev to a maximum value characteristic of the isotope. Their average energy is approximately one-third of the maximum value. The maximum energies of different isotopes lie in the range of 0 to 4 mev. The range of beta particles in air may be more than a meter for energetic betas, and such particles will penetrate several millimeters of aluminum or plastic.

Gamma emission is a secondary process following rapidly after certain alpha or beta decays. The emission of the latter particles may leave the nucleus in an unstable state, and the excess energy is released in the form of gamma radiation. Since gamma radiation has neither mass nor charge, there is no change in the atomic number or atomic weight of the emitting isotope.

The energies of gamma rays are mostly in the range of 0 to 2 mev, and the radiation from a single isotope will be made up of one or more groups of rays each having a single value of energy. Gamma rays can be very penetrating. Absorbing material does not completely stop gamma rays, but only reduces their intensity. For example, the gamma radiation from radium is reduced to 50 per cent of its incident value by ½ inch of lead. One inch would pass 25 per cent, 1½ inches 12.5 per cent and so on. Therefore, we speak of the half-thickness of a given absorber material for a particular gamma emitter rather than its range.

Most of the known radioisotopes emit alpha or beta particles, sometimes accompanied by gamma rays. Three other less common processes—

positron emission, electron capture, and internal conversion—should however be considered.

The positron is similar to a beta particle but has a positive charge. A typical reaction would be

$$_{15}P^{30} \longrightarrow e^{+} + {}_{14}Si^{30}$$

All the effects of beta-radiation are present, and in addition, 0.51 mev gamma rays are always emitted. These result when the positron loses its kinetic energy by absorption and combines with a normal electron. The two particles are annihilated and their mass is completely transformed into gamma energy.

The reaction for *electron capture* is similar to positron emission, for example,

$$_{29}Cu^{64} + e \longrightarrow {}_{28}Ni^{64}$$

The electron is one of the extra-nuclear electrons from the original atom. Most commonly it is one of the innermost electrons and the process is called K capture. As the inner electron is replaced by an outer electron, x-rays are emitted. Whenever the nucleus is left in an unstable state after capture, gamma rays are also emitted.

When a nucleus emits gamma radiation, it is possible that some of the gamma rays may be absorbed by one of the extra-nuclear electrons in the atom. If this occurs, the electron may be ejected from the atom. This process is known as *internal conversion* and may be exemplified by,

$$_{27}Co^{60} \longrightarrow {}_{27}Co^{60+} + e^{-}$$

The electron emission leaves a charged cobalt ion which must combine with another electron to resume electrical neutrality. (Note that since the electron involved is extra-nuclear, there is no change in atomic number).

Internal conversion electrons may be distinguished from beta particles in that they have a single energy rather than a range from zero to a maximum. Theoretically, they could appear with any gamma emission. Possibly they do, but where the gamma ray energy is greater than 0.5 mev, the probability of internal conversion is very low. With lower energy gamma, the fraction of gamma rays causing internal conversion may become quite large.

All the decay processes described are the result of energy changes, which eventually result in the production of a stable nucleus. The excess energy of the unstable nucleus is released by one or more of these processes according to characteristic rates. These decay rates are discussed later in this section.

X-Radiation. The production of x-rays is not a spontaneous process. Also, in contrast to nuclear radiation, it is not the nucleus that is involved but the extra-nuclear electrons. These electrons may exist in many different energy states or levels. By the addition of energy, one of the electrons may be raised to a higher energy level. If this level is unstable, the electron will return to a lower energy level, and the atom will emit the energy in the form of radiation. Depending on the quantity of energy involved, the radiation may appear as infrared (heat), visible light, ultraviolet radiation or x-rays. X-rays have the highest energy, and are consequently the most penetrating and present the greatest hazard, although any of the others may cause damage to the skin.

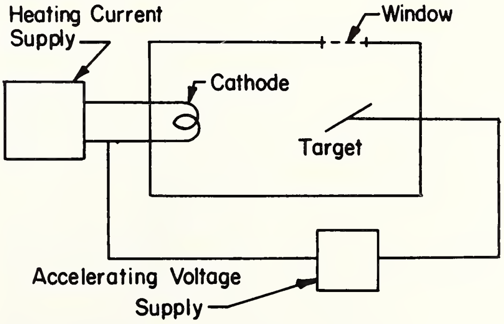

Figure 1. X-ray Tube

The excitation energy for the production of x-rays is derived from the acceleration of a stream of electrons by a high electric potential. A schematic diagram of an x-ray tube which converts electrical energy into x-ray energy is shown in Figure 1. A stream of electrons emitted by the heated filament is accelerated and strikes a target. Most of these electrons have their energy dissipated as heat in the target, but a fraction of them excite an extra-nuclear electron in an atom of the target material and produce x-rays.

Formerly, x-rays were considered to have lower energy than gamma rays, but the advent of multi-million volt x-ray installations has brought about an overlapping of their energy ranges. The true distinction lies, not in the energy but rather in the origin. Gamma radiation comes spontaneously from nuclear transformations, while x-rays are produced by excitation of extra-nuclear electrons. Like gamma radiation, x-rays have no mass or charge, only energy. The energies of the x-radiation produced by a tube depend on the target material and the acceleration voltage. Any target gives a continuous band of x-rays with peak intensities at energies characteristic of the target material.

Their maximum energy cannot be greater than the energy of the accelerating potential, and it is customary to describe x-rays in terms of the voltage used for acceleration, for example 75 or 200 kv. Actually, only a portion of the x-radiation produced would have energies of 75 or 200 kev and a considerable quantity of softer (lower energy) x-rays are always emitted. The intensity of an x-ray source is usually expressed not in terms of a number of x-rays of a particular energy produced, but in terms of the electric current flowing in the anode or target circuit. The description of x-radiation in terms of the instrument characteristics of voltage, current and target material may be roughly translated into the more fundamental physical units. However, the instrument characteristics are more often used to describe operation. Hazards or protective measures in this system will be discussed later.

The Natural Radioisotopes. The majority of the naturally-occurring radioisotopes are members of three series of elements. These series all have a long-lived radioisotope as the first member, and pass through a sequence of radioactive disintegrations involving alpha, beta, and gamma emission and end up as a stable isotope of lead. To the natural *uranium, thorium and actinium* series, the artificial *neptunium* series has been added by irradiation of uranium^{238} with neutrons in a reactor.

Other important naturally occurring radioisotopes are H^3, C^{14}, and K^{40}. These undergo a simple decay emitting beta particles and yielding stable isotopes.

Artificial Radioisotopes. Many man-made isotopes are now available. They include not only new isotopes of the natural elements, but entirely new elements. The new elements are those having an atomic number greater than that of uranium (92) and are called the transuranic elements. The most familiar one is plutonium, produced by neutron irradiation of ${}_{92}U^{238}$ in a reactor.

The nuclear reactor is designed to sustain a controlled fission process, where a fissionable element is split into two lighter elements. For example:

$$ {}_{92}U^{235} + {}_{0}n^{1} \longrightarrow {}_{38}Sr^{95} + {}_{54}Xe^{139} + 2\,{}_{0}n^{1} $$

The reaction also produces about 200 mev of energy as well as 1 to 3 neutrons. These neutrons in turn cause fission in more atoms of the fissionable material (fuel). This chain reaction starts by spontaneous fission of a few atoms of fuel and is controlled by absorbing neutrons in excess of those required to maintain the reaction. The reactor is thus a source of a high flux of neutrons for irradiation.

The products of fission that may be separated chemically from the spent fuel consist of over 30 elements. These original isotopes are unstable and undergo a series of 1 to 6 beta decays before a stable isotope is formed. The average fission series consists of 3 or 4 members, so as many as 100 isotopes may be present in a sample of mixed fission products. The different elements may be separated chemically, but this process does not separate isotopes of the same element.

The major sources today of individual radioisotopes are neutron irradiation (in a reactor) or bombardment in an accelerator, such as a cyclotron, with protons or other particles. A typical transformation obtainable in a reactor, using the notation previously given, would be

$$_{15}P^{31} + {}_{0}n^{1} \longrightarrow {}_{15}P^{32}$$

producing an unstable phosphorus isotope which decays by beta emission,

$$_{15}P^{32} \longrightarrow {}_{16}S^{32} + e$$

A typical cyclotron-produced reaction would be

$$_{3}Li^{7} + {}_{1}H^{1} \longrightarrow {}_{4}Be^{7} + {}_{0}n^{1}$$

producing a beryllium isotope which decays by K capture

$$_{4}Be^{7} + e \longrightarrow {}_{3}Li^{7}$$

These processes of irradiation and bombardment as well as chemical separation of specific elements from fission products and from natural series produce radioisotopes of practically every element. The use of these isotopes in the laboratory, in medicine, and in industry has brought many benefits, and while most of them are hazardous materials, they can be handled safely.

The commonly used isotopes and their radiation properties are given under each element, in Section 10.

Radioactive Decay. Radioactive isotopes may be characterized by the rate at which they disintegrate. All isotopes follow the same law of disintegration but the rates differ. This law may be stated that a fixed fraction of the number of atoms present disintegrate in a unit time. The fraction, which differs for different isotopes, is known as the disintegration constant and is a fundamental constant for each radioisotope. Another way of expressing the same thought is that for each isotope there is a period of time during which half of the atoms initially present will disintegrate. This time is defined as the half-life of the radioisotope. Thus if a given number of atoms is present at a particular instant, ½ of them will have decayed after 1 half-life, ¾ after 2 half-lives, and so on. Mathematically the number of atoms remaining at any given time may be expressed

$$N = N_0 e^{-\lambda t}$$

where

N_0 = the original number of atoms
λ = the disintegration constant
t = the time

(t and λ must be expressed in consistent units.)

The half-life relationship may be arrived at from the above equation as

$$T_{0.5} = 0.693/\lambda$$

This simple relationship between half-life and disintegration constant is quite useful since λ is the basic unit used by the physicist while $T_{0.5}$ is the common unit. The actual half-lives of the known isotopes range from 10^{-6} seconds to 10^{17} seconds. This value is fixed, as the rate of radioactive decay is apparently independent of physical variables such as temperature, pressure or concentration. It is a valuable characteristic in a practical sense, since it may be used to help evaluate hazard from exposure to certain materials.

Absorption of Radiation. The single property shared by all forms of radiation is energy. Any radiation is a form of energy, and it is the dissipation of this energy in matter that causes biological damage or that allows us to detect and measure radiation. X-rays and gamma-rays are electromagnetic energy; the alpha and beta particles possess kinetic energy. While these two types of energy are quite different, the effect they produce in matter is much the same.

In passing through matter nuclear and x-radiations lose their energy principally by causing ionization in the absorbing material. In this process, neutral atoms of the absorber are ionized, yielding an electron and a positively charged ion. The electrons may acquire sufficient kinetic energy so that they cause further ionization in the absorber. The original ion-electron pairs are spoken of as primary ionization, and those produced by the electrons as secondary ionization. Each ion pair requires the same amount of energy for production; the excess energy imparted in any ionizing event appearing as kinetic energy of the electron which then causes secondary ionization. Thus a certain amount of energy when dissipated in an absorber will produce a certain number of ion pairs. This is true whether the energy is introduced as x-rays or as nuclear radiation.

The average energy required to produce an ion pair in air is 32.5 ev for either primary or secondary ionization. The total energy of any particle or ray will be expended in producing these ion pairs, so that the number of ion pairs resulting from any radiation may be calculated. When the ions and electrons recombine, the ionization energy will appear in the absorber as heat. In fact, one method of determining the total energy produced by strong sources is by measurement with a calorimeter, an instrument designed to determine the amount of heat produced in a process.

Particulate radiation, alpha and beta, has a finite range in an absorber and this range is dependent on the energy of the particle. One method of determining the approximate energy of alpha or beta radiation is to determine the amount of absorber which just absorbs the radiation completely.

Electromagnetic radiation, x-ray and gamma, does not have a finite range but is reduced in intensity as described earlier. The half thickness or amount of absorber required to reduce the radiation intensity to one-half is the characteristic of electromagnetic radiation dependent on the energy of the rays. Determination of the half thickness may be used to measure the energy of x- and gamma-radiation. A further description of absorption will be found on p. 84.

Units of Radiation

In relating the measured values of isotope radiation to the predicted or actual biological effects produced by this radiation, two distinct types of units have arisen. The first, based on the number of radioactive disintegrations per unit time, is a measure of the quantity of the isotope present. This is, in effect, a unit of radiation flux whether measured at the source or at a considerable distance. The second type of unit is one of radiation dose, measured in terms of the quantity of radiation that is absorbed, and is more directly a measure of the possible biological effect.

The relationship between flux and dose units for radioisotopes is not simple and cannot be readily calculated with any degree of accuracy. Such a relationship can be determined empirically for an individual isotope but is only valid under conditions which are identical with those used in determining the relationship.

A similar relationship of flux and dose exists for x-rays. This section will define and explain the various systems of units in common usage for radiation intensity, energy and dose.

Units of Radiation Intensity. The units of radiation flux differ for x-ray and isotope radiation. However, the basic principle is that radiation flux is the measure of the strength of the source. In the case of x-rays this can only be expressed in terms of the amount of energy dissipated by the x-ray tube. The common units are milliamperes of plate current flowing in the tube. This energy includes both that emitted as x-radiation and that dissipated as heat within the tube. However, if the operating voltage, plate current and the efficiency of the x-ray tube are known, the radiation flux may be calculated; that is, the product of voltage and current expresses the wattage dissipated and the product of this wattage and efficiency would give the wattage of x-ray produced. The conversion to other energy terms such as ergs per minute may be made with conversion factors.

The energy of the individual x-rays is determined by the target material in the x-ray tube and the operating voltage. Flux, which is a measure of the number of emitted rays, must include the other factors mentioned. However, the number of x-rays emitted by a source is not a common characteristic for describing flux.

In the case of isotopes, the source flux (activity) means the number of radioactive disintegrations occurring in the source per unit time. As in the case of x-rays, this is the total of the radiation emitted and dissipated within the source itself. The actual emission can only be determined by measurement and the correction factor obtained would include both the geometrical effects and the absorption of the radiation within the source.

The practical units for radioisotopes are disintegrations per minute, abbreviated d/m, or per second, abbreviated d/s. More intense sources may be expressed in terms of the curie, which is equivalent to 2.2×10^{12} d/m. This unit is based on the number of radioactive disintegrations shown by the radon daughter of radium when it is in equilibrium with one gram of radium. Smaller units such as the millicurie (mc) and microcurie (μc) are 1/1000 and 1/1,000,000 of a curie, respectively. The rutherford (rd), equivalent to 10^6 d/s, has been suggested as a simpler unit for the curie, but has never become popular. Again, it should be emphasized that these units express only the source activity or the quantity of radioisotope present and not the radiation dose which this quantity would produce.

Units of Energy. The energy of any radiation is expressed in terms of electron-volts. An electron volt is the energy which would be acquired by an electron accelerated by an electrical potential of one volt. In terms of the more common units of physics the electron-volt is 1.60×10^{-12} ergs. This unit is so small that energies are usually given in thousands of electron-volts (kev) or millions of electron volts (mev). The introduction of the new and high-powered accelerators has also brought billion electron-volts (bev) into the physicist's vocabulary.

The usual range of energies for the common radiations are tabulated below:

Radiation	*Energy*
X-rays	8 kev to 2 mev
Alpha particles	4 to 8 mev
Beta particles	0 to 3.5 mev
Gamma rays	0 to 3 mev

These ranges include most of the radiations from the common isotopes and x-ray equipment, but higher energies of radiation do exist. The energies shown are for single particles or rays. The total energy rate of emission of a source would be the product of the individual energy and the number of particles or rays per unit time. This product would give a different measure of source activity (radiation flux), as for example, mev per minute.

Units of Radiation Dose. *Radiation dose* is a measure of the amount of energy that is absorbed in the material being irradiated. *This is the only quantity which can be related to biological effect.* The instruments and measurements of health protection are therefore designed in terms of radiation dose. The basic quantity is the amount of energy absorbed per unit mass of material and the practical unit is the roentgen (r). This is a purely arbitrary unit which has been set up as the quantity of x- or gamma radiation such that the associated ionization per cubic centimeter of air at standard conditions will produce 1 electrostatic unit (esu) of electricity of either sign. A more useful definition is that the roentgen is the quantity of x- or gamma-radiation which results in the absorption of 83.4 ergs per gram of air.

This unit was set up at a time when only the dosage from x- or gamma-radiation was considered to be important. The equivalent absorption for tissue was found to be approximately the same as that for air. When it became necessary to consider the dosage from beta and alpha particles the unit of roentgen equivalent physical (rep) was developed. This is the amount of ionizing radiation which will result in absorption of 93 ergs* per gram of tissue. This modification took into account the relative ionization produced in air and in tissue by these particles. In addition, the biological effects of a given quantity of energy absorption were supposed to be higher for alpha radiation, neutrons and protons than for the others. The corresponding factor for alpha radiation has been set at 20 and a new unit was devised to incorporate this factor. For alpha radiation in particular the roentgen equivalent man (rem) is defined as the quantity of radiation which when absorbed by man produces an effect equivalent to the absorption of one roentgen of x- or gamma-radiation. The factor of 20 is called the relative biological effectiveness (RBE) and is used as a multiplying factor. For example, if measurement in air of alpha radiation showed one roentgen, the possible biological effect would be more closely approximated if the result were given as 20 rem.

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*In July of 1953, the International Commission on Radiological Units adopted the rad, equal to 100 ergs per gram, as the unit for absorbed dose in tissue.

By applying these various terms, it was hoped to develop a system for expressing dosages which would be additive when exposure to several types of radiation had occurred. There is still hope that a simple compatible system of dose units will be agreed on in the future.

Two distinctions must be kept in mind. The first is that measurements are ordinarily made in terms of dose rate; that is, roentgens or milliroentgens per hour, while chronic biological effects are assessed in terms of integrated dose, i.e., total roentgens or milliroentgens. The second distinction is that the roentgen or rad is defined in terms of energy absorption per unit weight or volume. Thus, a total body dose of 100 mr would indicate a much greater total quantity of radiation absorbed than a 100 mr dose to one hand or arm. No description of dose is complete unless it tells the amount of material or portion of the body involved.

The permissible levels for radiation exposure which had been adopted are based on the value of a maximum of *0.3 roentgen per week or a total per year of 12 roentgens* to the whole body.* With our present knowledge, we feel that this level can be absorbed by a man for a working lifetime without the appearance of any sign of body damage. Realizing that fluctuations in exposure may occur, it is considered permissible to sum the total exposure over a 13-week period. This sum should not exceed 3.0 roentgens. Thus, if a person receives more than the weekly limit in a given week, the overexposure may be compensated for by reducing his exposure during the succeeding 12 weeks. This is valid for preventing damage and is more realistic as an operating procedure. In the case of radiation other than x- or gamma rays, the weekly maximum limit is 0.3 rem. An idea of the magnitude of the permissible levels can be obtained by a study of Tables 1, 2 and 3 which show various radiation dosages and effects.

Table 1, taken from Stone (1), cites the normal radiation levels from

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* Permissible levels are covered in detail on pages 88-91.

Table 1. Unavoidable Daily Dose of Radiation

Source		Dose per Day in Roentgens	Data from
Cosmic rays at sea level		0.0001	Sievert (a)
Cosmic rays and local gamma		0.0003	Evans (b)
Naturally-occurring radioelements		0.0010	Sievert (a)
Cosmic rays and ground radiation		0.0020	Lea (c)
Radioelements in the body		0.0001	Brues (d)
Carbon^{14}	3×10^{-6}		
Potassium^{40}	1×10^{-4}		
Radium	4×10^{-6}		

(a) Sievert, R. M., "Tolerance Dose and the Prevention of Injuries Caused By Ionizing Radiations," Brit. J. Radiol., 20, 306-318, August 1947.

(b) Evans, R. D., "Quantitative Inferences Concerning the Genetic Effects of Radiation on Human Beings," Science, 109, 299-304, March 25, 1947.

(c) Lea, D. E., "Actions of Radiations on Living Cells," New York, Macmillan, 1947.

(d) Brues, A. M., "Carcinogenic Effects of Radiation," in Lawrence, J. H., and Hamilton, J. G., "Advances in Biological and Medical Physics," New York, Academic Press, Vol II, 1951.

natural sources, to which everyone is exposed. Table 2, from a report given at a Health Physics Insurance Seminar in March, 1951 (2), shows the radiation exposure received in various diagnostic x-rays. Table 3, from the same source, shows the effects that can be expected from various large instantaneous doses of gamma radiation.

Table 2. Diagnostic X-ray Exposures

14 x 17 in. Chest plate	0.05 r
Photofluoroscopic chest	0.1 to 1.2 r
Extremities	0.25 to 1.0 r
Skull	1.3 r
Abdomen	1.3 r
Gastrointestinal series	0.65 r/plate
Lumbar, spine lateral	5.7 r
Pregnancy lateral	9.0 r
Fluoroscopy	0.28 r/sec

Physical and Biological Effects of Radiation

The direct effects of radiation with which we are concerned are those on the cells or tissues exposed to the radiation. The five principal damaging effects are:

(a) Superficial injuries such as skin damage or erythema.

(b) General effects on the body, particularly the bloodforming organs.

(c) Induction of malignant tumors.

(d) Miscellaneous effects such as cataract or impaired fertility.

(e) Genetic effects.

All the effects mentioned are possible with excessive exposure to ionizing radiation. However, the first four (a, b, c, and d) can occur only through rather extreme overexposure and the permissible level is set at the present value almost entirely on the basis of (b) (c) and (d). For example, about 250 roentgens would be necessary to give a superficial radiation burn from x-ray in single dose. The lifetime dose permitted under present standards is only slightly over 300 roentgens. The evaluation of possible genetic effects is still controversial. However, recent genetic data is causing some of our radiation protection advisory groups to recom-

Table 3. Effects From Large Acute Radiation Doses

Total Body Exposure to Gamma Rays, r	Result
0 - 50	No readily detectable damage
50 - 100	Detectable damage
200	Would probably kill 10%
400	Would probably kill 50%
600	Would probably kill 75%
800	Would probably kill 90%
1000	Would probably kill 95%

mend lowering the permissible levels.

Since the same physical processes are involved in the absorption of radiation, whether the absorber is air, metal or tissue, we must first consider the general action of radiation when it is absorbed in any material.

The primary effect of the absorption of radiation in matter is that of ionization. Atoms of the absorber are given sufficient energy so that they ionize; that is, an electron is removed from the atoms leaving a positively charged residue or ion. This ionization takes place in any substance which absorbs radiation. Very roughly, if the amount of absorber in the path of the radiation is expressed in terms of the weight per unit area, the degree of absorption is independent of the material.

For both scientific and practical purposes the common units are grams or milligrams per square centimeter of absorber. This quantity is obtained by multiplying the thickness of absorber, expressed in centimeters, by the density, expressed in grams per cubic centimeter. This product will be in units of grams per square centimeter. For example, if the beta radiation from a source would be completely absorbed by 1100 mg per square centimeter of aluminum it would also be absorbed by 1100 mg per square centimeter of air. However, the absorber thickness would be only about 1/4 inch for the aluminum and over 30 feet for air.

The result of ionization is merely a conversion of the radiation energy into another form of energy within the absorber. This energy may still be released in such a way as to cause other effects within the absorber, and it is these secondary effects which are of the greatest importance in radiation protection work.

The primary effects of ionization and the distribution of this ionization over various path lengths in different absorbers have been mentioned previously. The different types of radiation also show different degrees of absorption and these differences also are biologically significant. Alpha particles are heavy, slow moving, and expend their energy in a relatively short path. They are, therefore, spoken of as showing high specific ionization; that is, a large number of ions are formed per unit length of path in the absorber. Gamma- and x-radiation, on the other hand, require a great thickness of absorber for complete absorption. Gamma and x-rays have a low specific ionization; that is, the ionization is spread out over the long path required for complete absorption. Beta particles are intermediate in their specific ionization.

Many secondary effects can be caused by the ionization process. It may disrupt molecules, it may destroy body cells or the energy may merely appear in final form as heat released within the absorber. Depending on the location of the absorbing atom within the molecule, the ionization may or may not disrupt the molecule. If this molecule is in a critical place within the cell, the cell may be destroyed, its function may be destroyed or its ability to reproduce itself may be destroyed. Many of these processes are reversible; that is, damage caused by molecule disruption or cell destruction can be reversed by the usual reparative mechanism of the body.

However, in the case of a large acute dose or continued chronic overexposure, there is the possibility that nonreversible damage will occur.

Another type of cell change which is possible is that the regulative functions of a tissue may be destroyed. In this case a carcinoma may be produced. Although the mechanism is not fully understood, there is direct evidence that continued insult to a tissue may produce this result. The high rate of leukemia among radiologists, bone cancer among radium dial painters and lung cancer among miners of the Czechoslovakian and German uranium mines all point to radiation as the causative agent. The therapeutic use of x-rays and isotopes depends on their ability to destroy cells and the fact that tumorous cells are more sensitive to radiation than normal cells. However, this therapy must be carefully applied, as exposure to this same radiation can cause the outbreak of a new malignant growth.

The effects from chronic radiation exposure which are of concern in personnel protection are those which produce an irreversible change. The irreversible damage in chronic radiation exposure is apparently cumulative and the cumulative effects lead to the well-known delayed illnesses caused by radiation. Like acute radiation damage, delayed effects can be either localized in certain sections of the body or may be general for the entire body.

The actual mechanism of cell damage has been explained by two theories. One is the target or "single or multiple hit" theory which assumes that the ionization takes place in the molecules of a vital cell area, perhaps the cell nucleus. If such an event occurred, the cell would be irreversibly damaged. The number of cells damaged or the amount of damage would depend only on the total radiation dose, not upon the dose rate. The amount of damage would depend also on the probability of an individual ionizing event taking place within the particular molecules of the vital cell area. The other theory allows for more general absorption of radiation within a cell producing chemical changes and consequent cell damage due to toxic systems formed by the ionization. These chemical changes could occur outside the particular cells as well as within them and still produce toxic systems leading to chemical changes in the cells themselves. The target theory has been used to explain the irreversible gene mutations occurring with radiation exposure. With such a theory no threshold dose would be required. Any amount of radiation whatsoever could cause gene mutations. The chemical change theory, on the other hand, would probably require a threshold dose to build up damaging quantities of the toxic systems formed by ionization.

Biological Effects. The biological effects of radiation are complicated by several factors. In any determination of radiation effects, whether on working populations or in animal experiments, the following factors must be considered: (1) the location of specific elements in the body, (2) the relative sensitivity of different tissues to radiation and (3) the fact that radiation does not cause any new diseases but can increase the degree of incidence of certain diseases above the normal.

The general effects of external radiation have been previously described but there are certain modifications in the consideration of radiation from internal sources. The first is that different elements tend to localize in different organs of the body; for example, calcium or strontium in bone, iron in the red blood cells and iodine in the thyroid. This is true for any material which is metabolized following either inhalation or ingestion. Of course, many difficultly soluble substances will remain in the lungs for long periods after inhalation. This means that the total amount of such a radioactive material is not distributing its dose uniformly over the whole body but rather, concentrating the effect in a relatively small fraction of the total body.

Most of the heavy metals tend to be deposited in the bone structure. After deposition, there is usually a continuous excretion of the isotope which will gradually reduce the amount present. The excretion rate of such materials follows much the same pattern as the radioactive decay of an isotope. Using similar terminology we speak of the "biological half-life," of a material which has been deposited in the body and is being eliminated. The time required by the body to eliminate one-half the total quantity it contains is thus referred to as "biological half-life."

Such body deposits may depend on many physiological factors both in the process of deposition and of excretion. For many years a high calcium diet was recommended for radium workers, as it was supposed that a large excess of calcium entering the body would reduce the amount of radium deposition. Actually, the relative radium deposition is a function of the ratio of radium to calcium in the blood stream. Unless the calcium level of the blood is retained at a very high value there will still be deposition of radium. The increase in the blood calcium required to cut the radium deposition by even a factor of 3 would be impossible to attain.

Besides the bone structure, common sites of deposition are the lungs and lymph nodes for inhaled particulates, and certain specific organs for certain isotopes, such as the thyroid for iodine, and the spleen for iron.

A second consideration is that certain organs or tissues are more radiosensitive than others. The membranes lining the bronchi are supposedly quite sensitive to radiation and this is the primary site of many lung cancers attributed to inhaled radioactive material.

The spleen also is sensitive to radiation and relatively small doses have produced more irreversible damage in that organ than in other parts of the body. The organ most likely to be damaged because of the combined effects of concentration and radiosensitivity is known as the critical organ for a particular isotope. In general, any cell in the process of division (mitosis) is radiosensitive and for that reason a person is more sensitive to radiation during his growing period than he would be as an adult.

The effects of radiation are nonspecific; that is, other agents or diseases can cause the same damage; for example, anemia has a normal incidence in man and the separation of a radiation-induced anemia from natural incidence is difficult if not impossible. Other possible effects, such as lung cancer, leukemia and bone cancer present similar difficulties.

In any case, where the effects of radiation are being studied, conclusions can only be drawn on the basis of incidence of a particular type of damage above that normally occurring in the population. If tabulations are made of incidence in a particular group, such as the chemical operators in a process plant involving radiation exposure, the effects of radiation can only be evaluated by statistical comparison with a similar group exposed to the same chemical hazards but without the radiation.

Any toxicological agent shows that different people exhibit differing degrees of sensitivity. This is also true of radiation effects. Many of the early injuries to radium dial painters occurred with relatively small amounts of radium deposited in the body. Other workers with many times as much radium deposited in their bodies showed no injury even after many years.

All these factors make it quite difficult to evaluate radiation effects in humans. Even though a particular type of damage could have been entirely natural, the tendency, in compensation decisions particularly, is to assign it to radiation. This, of course, has been equally true for other industrial hazards that have become part of our experience in industrial hygiene. All of which makes it imperative that the occupational exposure of each individual be evaluated and recorded continuously.

Radiation Hazards

Any agent which may cause body damage is ordinarily classified in terms of relative hazard from an acute dose compared with a chronic dose, and the hazard when the material is outside the body compared to that when it is inside. The possible acute effects of large overexposures can occur only where powerful x-ray equipment or large amounts of radioisotopes are being used. The mere presence of such high level hazards requires considerable care to avoid acute overexposure. Usually, the radiation control problem which is met is the reduction of chronic low level exposures. The fact that relatively low power x-ray equipment or small quantities of isotopes are being handled makes it more difficult to maintain safe standards. Again, it should be stressed that since radiation is not detectable by the senses at the time of exposure, the control problem becomes very difficult. However, experience has shown that chronic low level overexposure can produce many harmful effects in man and therefore must be controlled.

Radioisotopes, in contrast to x-rays, may present a further hazard when the material is taken into the body, and irradiates the tissues or organs internally. The most serious hazards from this standpoint are the alpha emitters such as radium, uranium and plutonium. They are particularly marked, because as alpha emitters they are not hazardous outside the body since the short range particles would expend their energy

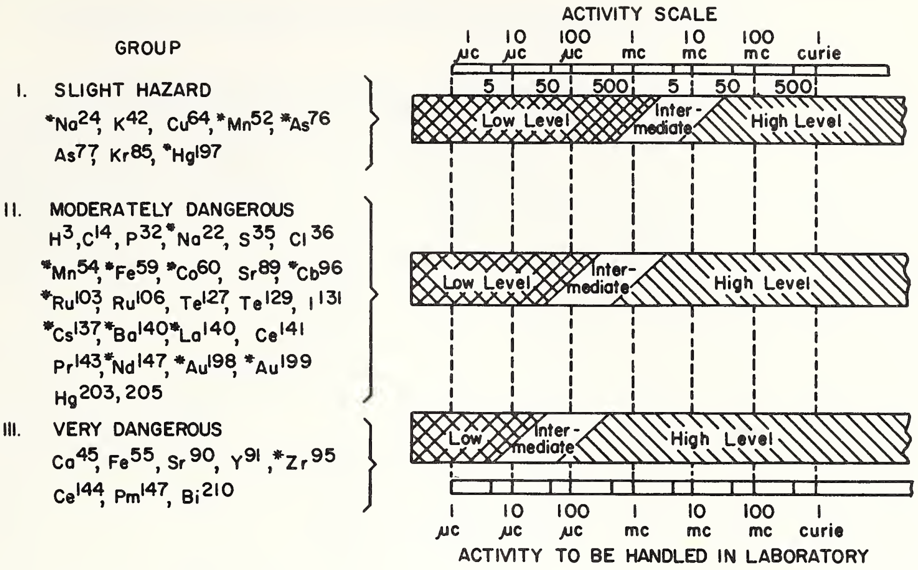
GROUP
I. SLIGHT HAZARD
$^*Na^{24}$, K^{42}, Cu^{64}, $^*Mn^{52}$, $^*As^{76}$
As^{77}, Kr^{85}, $^*Hg^{197}$
II. MODERATELY DANGEROUS
H^3, C^{14}, P^{32}, $^*Na^{22}$, S^{35}, Cl^{36}
$^*Mn^{54}$, $^*Fe^{59}$, $^*Co^{60}$, Sr^{89}, $^*Cb^{96}$
$^*Ru^{103}$, Ru^{106}, Te^{127}, Te^{129}, I^{131}
$^*Cs^{137}$, $^*Ba^{140}$, $^*La^{140}$, Ce^{141}
Pr^{143}, $^*Nd^{147}$, $^*Au^{198}$, $^*Au^{199}$
$Hg^{203, 205}$
III. VERY DANGEROUS
Ca^{45}, Fe^{55}, Sr^{90}, Y^{91}, $^*Zr^{95}$
Ce^{144}, Pm^{147}, Bi^{210}
ACTIVITY SCALE
1 μc
10 μc
100 μc
1 mc
10 mc
100 mc
1 curie
5
50
500
5
50
500
Low Level
Inter-mediate
High Level
Low Level
Inter-mediate
High Level
Low
Inter-mediate
High Level
1 μc
10 μc
100 μc
1 mc
10 mc
100 mc
1 curie
ACTIVITY TO BE HANDLED IN LABORATORY

Figure 2. Hazard from Absorption into the Body

Selected radioisotopes grouped according to relative radiotoxicity with the amounts considered as low, intermediate, or high level, in laboratory practice.

Notes

Effective radiotoxicity is obtained from a weighting of the following factors:

Half-life.
Energy and character of radiations.
Degree of selective localization in the body.
Rates of elimination.
Quantities involved and modes of handling in typical experiments.

The slant boundaries between levels indicate border-line zones, and emphasize that there is no sharp transition between the levels and the associated protection techniques.

The principal gamma-emitters are indicated by asterisk (e.g., $^*Na^{24}$). The above level system does not apply to the hazards of external irradiation.

Reproduced from NBS Handbook 42 (3).

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either in the clothing or in the dead cells of the epidermis. As long as they are outside the body, alpha particles cannot penetrate to living cells and cause biological damage. Once they are taken into the body, this same property of short range and high specific activity increases their relative hazard considerably. Alpha emitters in a small section of tissue will irradiate that small section very heavily, and the probability of non-reversible biological damage at that point is greatly increased.

Beta emitters can be both an internal and external hazard. The range of most beta radiation is great enough that the outer tissues, at least, will be penetrated. The most common external effects have been radiation burns and malignancies of the skin. Internally, they present a considerable hazard although it is not as great as alpha radiation for equal activities. Gamma radiation could possibly be an internal hazard but the major problems associated with gamma radiation are the dangers from external radiation, as in the case of x-rays.

Figure 2 shows the relative hazard from various isotopes when taken into the body. It represents a grouping of the common beta and gamma emitters used in the laboratory and does not include alpha emitters.

Table 4. Permissible Levels for Various Isotopes

A. Common radioisotopes that are alpha emitters

Element	Organ (g)	Microcuries in Total Body	Microcuries per Milliliter of Water	Microcuries per Milliliter of Air
Po^{210} (sol.)	Spleen, 150	0.02	3×10^{-5}	2×10^{-10}
Po^{210} (insol.)	Lungs, 10^3	7×10^{-3}		7×10^{-11}
Rn^{222} + dr (c)	Body, 7×10^4 Lungs, 10^3		2×10^{-6}	10^{-3}
Ra^{226} + ½ dr (c)	Bone, 7×10^3	0.1	4×10^{-8}	8×10^{-12}
U-nat'l (sol.)	Kidneys, 300	0.2 (a)	7×10^{-5}(a)	1.7×10^{-11}(a)
U-nat'l (insol.)	Lungs, 10^3	0.009		1.7×10^{-11}
U^{233} (sol.)	Bone, 7×10^3	0.04	1.5×10^{-4}	1×10^{-10}
U^{233} (insol.)	Lungs, 10^3	0.008		1.6×10^{-11}
Pu^{239} (sol.)	Bone, 7×10^3	0.04	1.5×10^{6}	2×10^{-12}
Pu^{239} (insol.)	Lungs, 10^3	0.008		2×10^{-12}

B. Beta- and gamma-emitting radioisotopes that are of interest because they are common body elements

Element and Percentage in Body	Organ (g)	Microcuries in Total Body	Microcuries per Milliliter of Water	Microcuries per Milliliter of Air
H^3(HTO or $H^3{}_2O$), 10%	Total body, 7×10^4	10^4	0.2	2×10^{-5}
C^{14} (CO_2), 18%	Fat, 10^4 Bone, 7×10^3	250 1,500	3×10^{-3} 4×10^{-3}	10^{-6} 5×10^{-7}
Na^{24}, 0.15%	Total body, 7×10^4	15	8×10^{-3}	2×10^{-6}
P^{32}, 1.0%	Bone, 7×10^3	10	2×10^{-4}	1×10^{-7}
S^{35}, 0.25%	Skin, 2×10^3	100	5×10^{-3}	10^{-6}
Cl^{36}, 0.15%	Total body, 7×10^4	200	2×10^{-3}	4×10^{-7}
K^{40}, 0.35%	Muscle, 3×10^4	20	1×10^{-2}	2×10^{-6}
Ca^{45}, 1.5%	Bone, 7×10^3	65	5×10^{-4}	3×10^{-8}
Mn^{56}, 3×10^{-4}%	Kidneys, 300 Liver 1.7×10^3	2 7.5	0.15 0.3	3×10^{-6} 4×10^{-6}
Fe^{55} Fe^{59} 0.004%	Blood, 5×10^3 Blood, 5×10^3	1×10^3 11	4×10^{-3} 1×10^{-4}	6×10^{-7} 1.5×10^{-8}
Cu^{64} 2×10^{-4}%	Liver 1.7×10^3	1.5×10^2	8×10^{-2}	6×10^{-6}
Zn^{65}, 0.003%	Bone, 7×10^3	430	6×10^{-2}	2×10^{-6}
I^{131}, 4×10^{-5}%	Thyroid, 20	0.3	3×10^{-5}	3×10^{-9}

Table 4. Permissible Levels for Various Isotopes (cont.)

C. Other radioisotopes of current interest

Element	Organ (g)	Microcuries in Total Body	Microcuries per Milliliter of Water	Microcuries per Milliliter of Air
Be^{7}	Bone, 7×10^{3}	670	1	4×10^{-6}
F^{18}	Bone, 7×10^{3}	24	0.9	10^{-4}
A^{41}	Total Body, 7×10^{4}	30	5×10^{-4}	5×10^{-7}
Sc^{46}	Spleen, 150	6	0.4	7×10^{-8}
V^{48}	Bone, 7×10^{3}	20	0.5	10^{-6}
Cr^{51}	Kidneys, 300	390	0.5	8×10^{-6}
Co^{60}	Liver, 1.7×10^{3}	3	2×10^{-2}	10^{-6}
Ni^{59}	Liver, 1.7×10^{3}	39	0.25	2×10^{-5}
Ga^{72}	Bone, 7×10^{3}	8	9	3×10^{-6}
Ge^{71}	Kidney, 300	67	9	4×10^{-5}
As^{76}	Kidney, 300	10	0.2	2×10^{-6}
Rb^{86}	Muscle, 3×10^{4}	60	3×10^{-3}	4×10^{-7}
Sr^{89}	Bone, 7×10^{3}	2	7×10^{-5} (b)	2×10^{-8} (b)
Sr^{90} + Y^{90} (c)	Bone, 7×10^{3}	1	8×10^{-7}	2×10^{-10}
Y^{91}	Bone, 7×10^{3}	15	0.2	4×10^{-8}
Nb^{95}	Bone, 7×10^{3}	90	4×10^{-3}	4×10^{-7}
Mo^{99}	Bone, 7×10^{3}	50	14	2×10^{-3}
Tc^{96}	Kidneys, 300	5	3×10^{-2}	3×10^{-6}
Ru^{106} + Rh^{106} (c)	Kidneys, 300	4	0.1	3×10^{-8}
Rh^{105}	Kidneys, 300	9	1.5×10^{-2}	10^{-6}
Pd^{103} + Rh^{103} (c)	Kidneys, 300	6	1×10^{-2}	7×10^{-7}
Ag^{105}	Liver, 1.7×10^{3}	18	2	10^{-5}
Ag^{111}	Liver, 1.7×10^{3}	36	4	3×10^{-5}
Cd^{109} + Ag^{109}m (c)	Liver, 1.7×10^{3}	40	7×10^{-2}	7×10^{-8}
Sn^{113}	Bone, 7×10^{3}	80	0.2	6×10^{-7}
Te^{127}	Kidneys, 300	4	3×10^{-2}	10^{-7}
Te^{129}	Kidneys, 300	1.3	10^{-2}	4×10^{-8}

Table 4. Permissible Levels for Various Isotopes (cont.)

C. Other radioisotopes of current interest (cont.)

Element	Organ (g)	Microcuries in Total Body	Microcuries per Milliliter of Water	Microcuries per Milliliter of Air
Xe^{133}	Total body, 7×10^4	300	4×10^{-3}	4×10^{-6}
Xe^{135}	Total body, 7×10^4	100	1×10^{-3}	2×10^{-6}
Cs^{137} + Ba^{137m} (c)	Muscle, 3×10^4	90	1.5×10^{-3}	2×10^{-7}
Ba^{140} + La^{140} (c)	Bone, 7×10^3	5	2×10^{-3}	6×10^{-8}
La^{140}	Bone, 7×10^3	24	1	10^{-6}
Ce^{144} + Pr^{144} (c)	Bone, 7×10^3	5	4×10^{-2}	7×10^{-9}
Pr^{143}	Bone, 7×10^3	29	0.4	7.5×10^{-7}
Pm^{147}	Bone, 7×10^3	120	1	2×10^{-7}
Sm^{151}	Bone, 7×10^3	420	0.2	10^{-8}
Eu^{154}	Bone, 7×10^3	22	3×10^{-2}	6×10^{-9}
Ho^{166}	Bone, 7×10^3	17	23	3×10^{-6}
Tm^{170}	Bone, 7×10^3	19	0.25×10^{-1}	5×10^{-8}
Lu^{177}	Bone, 7×10^3	78	24	5×10^{-6}
Re^{183}	Thyroid, 20 Skin, 2×10^3	35 600	8×10^{-2} 0.2	8×10^{-6} 2×10^{-5}
Ir^{190}	Kidneys, 300	21	10^{-2}	7×10^{-7}
Ir^{192}	Kidneys, 300	3.4	9×10^{-4}	5×10^{-8}
Au^{198}	Kidneys, 300	10	3×10^{-3}	1×10^{-7}
Au^{199}	Kidneys, 300	28	7×10^{-3}	2.5×10^{-7}
Hg^{203}	Bone, 7×10^3	57	0.1	6.5×10^{-6}
At^{211}	Thyroid, 20	6×10^{-4}	2×10^{-6}	3×10^{-10}
Th^{234}	Bone, 7×10^3	120	3	6×10^{-7}
Am^{241}	Bone, 7×10^3	0.056	10^{-4}	3×10^{-11}
Cm^{242}	Bone, 7×10^3	0.05	9×10^{-4}	2×10^{-10}

Footnotes to Table 4.

(a) Based on chemical toxicity. The microcurie and microcurie-per-milliliter values are given for the natural mixture of U^{238}, U^{235}, and U^{234} with all the other radioisotopes removed.

(b) Obtained by a comparison of recommended values for Sr^{90} with the calculated values in the two cases.

(c) Values of microcuries and microcuries-per-milliliter are given for the parent element in equilibrium with its daughter element(s).

Permissible Levels

Table 4 gives a complete summary of the hazard of the permissible levels of radioisotopes in the body and in water and air. This table is slightly modified from that given in NBS Handbook 52 (4). It lists not only the permissible levels but also the critical organ for each isotope. The values were selected from those in the literature or were calculated to produce less than 0.3 rem per week to the critical organ.

None of the permissible levels that are accepted at the present time can be considered as absolute values. All of them are subject to modification as our experience increases.

A maximum permissible level can be set up in two ways; one is on the basis of the largest quantity of radiation or radioactive material which is known to have caused no damage to the exposed individuals, the other is the smallest amount that is known to have caused damage to exposed individuals. Fixing permissible levels could be done best if both the maximum and minimum figures were known. Our experience has been that usually the maximum value is obtained from known exposures of working populations, while the minimum values are obtained from animal experimentation.

Of course, in the case of x-rays and of ingested radium, the minimum values also come from human experiences. The weakness in evaluating human exposure is that the hazard is not recognized until some clinical evidence of damage appears and by that time satisfactory records of exposure are often not available. Animal experimentation is unsatisfactory because there must be a final extrapolation from animal experience to an estimate of what might be expected in humans. However, in spite of the failings of the available methods of determining maximum permissible levels, the values which have been set can serve as a standard for operation.

The approach to maximum levels in the case of radiation and radioisotopes has been more unified than the approach to setting levels for other toxic materials. The large proportion of work with radioactive isotopes in the past few years has been either a direct government function or has been under private contract with government agencies. This has meant that a centralized group has been studying the common problems appearing in all fields where radiation is a possible hazard. In addition, recognition by scientists that such a hazard exists has resulted in considerable group and community activity in evaluating hazards. The major authority in the field at present is the National Committee on Radiation Protection. This committee was organized in its present form in 1946 and, in cooperation with other committees and the International Commission on Radiological Protection, has set the present working standard for radiation protection. The committee has been organized into sub-committees of specialists in different fields and these sub-committees have published several handbooks on different types of radiation hazards under the auspices of the National Bureau of Standards. At the same time the parent committee has been able to coordinate the efforts of the smaller groups. The current handbooks are listed in the bibliography and additional ones will no doubt appear from time to time, both on new subjects and on modifications of the current material.

Permissible levels are based on a working lifetime for external radiation and continuous exposure for air concentrations. They refer to exposure above normal background radiation and are considered to include only exposures incurred in the course of work. Diagnostic or therapeutic x-rays are not included, but any person undergoing extensive x-ray treatment should temporarily avoid exposure to other sources of radiation. The permissible level for external radiation has been given as 3.0 roentgens summed over a 13 week period. This is the permissible level for whole body irradiation and may only be exceeded where exposure to non-radiosensitive organs alone is possible. The only limit of this type which has been specifically set is that the permissible dose to the hands and forearms may be three times that to the whole body. It must be realized

Table 5. Maximum Permissible Tissue Dose Limits in "Reps" Per Week Agreed on at the 1950 Chalk River Conference

Type of Radiation	At Any Point Within the Body	Relative Biological Effectiveness	In Basal Layer of Epidermis	
			Exposure of Entire Body	Exposure of Hands Only
X- and gamma rays	0.3	1	0.5	1.5
Beta particles	0.3	1	0.5	1.5
Protons	0.03	10	0.05	0.15
Alpha particles	0.015	20	0.025	0.075
Fast neutrons	0.03	10	0.05	0.15
Thermal neutrons	0.06	5	0.1	0.3

The values for x- and gamma rays and for beta particles are modified in NBS Handbook 59 (5) to allow 0.6 mrem to the skin, and 1.5 rem to feet and ankles or hands and forearms.

that this does not mean that three times the total amount of radiation may be received but only that the larger dose is permissible for the localized section. The distinction in the definition of the roentgen which is based on radiation absorbed per gram of tissue. Table 5 lists the accepted permissible levels for various types of radiation. NBS Handbook 59 (5) recommends that minors (under 18 years of age) receive no more than one-tenth the permissible levels. Since the fluctuations are not apt to be large at such low dose rates, averaging the weekly dose over a period of one year is permissible.

Measurement of Radiation

Film Measurement. Photographic film is the accepted standard for evaluation of personnel hazard from exposure to low radiation levels. The film most commonly used is x-ray film because of its high sensitivity. The ordinary dental film packet, originally manufactured for dental x-ray work, is very satisfactory and has the advantages of low cost, convenient size and ready availability in package form. Naturally, the degree of blackening of the film must be interpreted by means of microphotometer or densitometer in terms of radiation dose. This is done by calibration of the film with known amounts of radiation.

The film packet can be merely pinned to the work clothes or, if only penetrating radiation is encountered, it can be carried in the pocket. However, the common method of wearing is to enclose the packet in a holder (film badge) for convenience. This film badge allows identification of the film with the individual, it holds the film in the proper place with respect to the body and by being worn outside the clothing it can be made more responsive to less penetrating radiation such as beta particles. It also can be designed to distinguish between different energies or types of radiation. Many badge designs are currently available and all of these have advantages for the particular installation using them. Unless an installation employs a large number of workers with possible radiation exposure, the expense of setting up and operating a film badge service, including the calibration and processing of films, is very high. Fortunately, several reliable organizations offer a film badge service for smaller installations at a reasonable cost.

External Radiation. Two types of external radiation measurement are made; one is the general area survey made with a portable survey meter and the other is the measurement of individual exposure with one of the many personnel monitoring devices. The first is most useful for locating sources of radiation and evaluating possible hazard but is also valuable for the immediate determination of the effectiveness of corrective measures or of clean-up procedures. When used for exposure evaluation, particular care should be taken to make measurements with the detector probe in the locations occupied by the operator's body, as well as measurements throughout the entire working area.

Any instrument used for area surveys should be sensitive to the least penetrating radiation present. Survey meters are worthless unless they are maintained in proper condition and are calibrated frequently enough to assure the accuracy of the readings. Small "button" sources are available from the instrument manufacturers for frequent rough checks of operating conditions, but a calibration of the instrument on all scales should be made three or four times a year. Inaccurate or uncalibrated instruments can be dangerous if they give low readings in the presence of high radiation fields.

On the other hand, incorrect high readings may cause considerable expense in trying to correct a situation which does not actually exist. Calibration services are available from instrument manufacturers and from consulting laboratories in the field of radiation protection. If several instruments are in use, the cost of calibrating sources and their shielding will be negligible compared with the convenience of being able to run calibrations without having the instruments out of service for extended periods.

Personnel monitoring devices are either of the film badge type or the pocket ionization chamber type. Other devices are in the development stage but have not been accepted by those concerned with radiation protection. The film badge has been described and its utility is limited only by the requirement that the film be processed before a measure of radiation exposure can be obtained. This is perfectly satisfactory where the personnel monitoring is done only as a matter of record and there is no danger of high level exposures. If such exposures are possible, a pocket ionization chamber (dosimeter) in addition to the film is desirable. Pocket chambers are available in various ranges of total radiation dose and are made either as direct reading dosimeters with their own internal scale or as simple chambers which must be inserted in a reader to obtain the dose measurement. All of these operate by charging the chamber before use. Exposure to radiation causes ionization within the chamber and allows a portion of this charge to leak off. After wearing, the residual charge is measured and the amount of leakage related to the radiation exposure. The internal scale or the reader scale is calibrated directly in terms of dose received. Dosimeters can be read daily or hourly to follow the exposure level if the circumstances require. However, they are chiefly sensitive to gamma- or x-radiation, since the walls of the chamber will effectively cut out alpha and most beta particles. A disadvantage of the earlier units was that they sometimes became accidentally discharged or that the reading was shifted by severe jarring. It was standard practice, therefore, that dosimeters were worn in addition to a film rather than as a substitute.

Surface Contamination. The contamination of working surfaces (or other portions of the working area) with radioactive material is spoken of as surface contamination. If the isotopes are beta or gamma emitters, the contamination is a source of external radiation. The magnitude of this radiation can be best evaluated with survey equipment. Alpha emitters are not an external radiation hazard, but alpha contamination that later becomes air-borne or that is transported to the body of the individual can offer an internal hazard. This is true to a lesser extent for beta emitters.

Surface contamination is evaluated purely in terms of the amount present on the surface. The critical factor for alpha emitters is the amount of material which can become air-borne and available for inhalation or ingestion. Several methods of measurement have been devised, none of which is completely satisfactory. The most widely accepted method is to wipe a fixed area with a piece of filter paper and measure the activity taken up by the paper. The results are expressed in terms of d/m/100 sq centimeters or similar units. Since the correlation between the amount that can be wiped off with a paper and the amount that can become air-borne or can be picked up on the hands is not good, this cannot be considered as very meaningful. Low results from a wipe test should not lead to ignoring a non-removable surface contamination, as it is always desirable to keep working areas as free as possible from radioactivity. However, cleaning of such surfaces does not have to be performed on an emergency basis.

Airborne Radioactivity. Almost all operations involving radioisotopes may result in some of the activity becoming air-borne. This may arise from the dusting of dry materials, spraying from solutions, or from the liberation of radioactive gaseous products. It is common practice in both laboratory and plant processes to carry out all operations in enclosed hoods or with good general ventilation. The high toxicity of small amounts of some radioisotopes when taken into the body make the collection and evaluation of air-borne radioactivity a critical part of most radiation protection systems. Solid or liquid materials can be determined by drawing known quantities of air through a filter and measuring the activity collected on the filter. This can be an extremely rapid and accurate method of analysis.

Two types of hazard evaluation are possible. One is the continuous sampling of air-borne material in the work area for an over-all picture of the probable exposure. The other is the sampling of air in the operation breathing zone during the time that the actual process which may give rise to air-borne activity is being carried out. The maximum permissible levels for air-borne radioactivity in NBS Handbook 52 are given in terms of microcuries of material per milliliter of air based on a working lifetime exposure at 168 hours per week. These tolerances may be multiplied by 3 for a 40 hour per week exposure. Thus, a short, high level exposure may be averaged out with the general background level of the work area to determine the over-all exposure. Gaseous isotopes will, of course, not be collected on a filter. (The natural radon isotopes can be estimated, however, by the collection of their solid daughter products on a filter.) Other radioactive gases must be absorbed in a gas bubble washer or an impinger and the resulting solution treated to convert the activity to a form suitable for counting. Even this will not work with some of the inert gases such as krypton and argon and more elaborate methods are needed for their measurement. However, their production and measurement are very specialized problems only encountered in reactor operation.

Personnel Exposure. Measurement of air-borne dust or other activity is difficult on a continuous basis, particularly if it is desirable to monitor the exposure of each individual. Some evaluation is possible by measurements on the individual himself. For example, analysis for the amount of an isotope excreted in the urine of an individual may furnish an indication of relative exposure. While the conversion of the concentration of isotope in the urine to the concentration of that isotope in the air breathed is not always possible, the excretion does constitute a measure of the relative intake and can be valuable as a secondary means of exposure evaluation. No permissible levels for urine excretion have been set up, since in addition to the usual variables found in biological systems, others such as diet and fluid intake can cause marked fluctuations in the urinary concentration of an isotope. Urine analyses, therefore, are only valuable when a continuing sequence is maintained. Blood counts have been considered as an index of radiation exposure and are taken routinely at some installations. There is no indication of their value for evaluating low-level exposures, since the normal fluctuations in count mask any changes that might be produced by exposure to radiation. Direct personnel monitoring is more sensitive, reliable, and considerably simpler.

One specific personnel monitoring method is accepted for radium exposure evaluation. That is the measurement of the radon concentration in the expired air. Radon is one of the rare gases and an immediate daughter of radium. A portion of the radon formed by radium decay is transported to the lungs and appears in the exhaled breath. The value of 10^{-12} curies of radon per liter has been set as an indication of 0.1 microgram of radium in the body. This latter value is the maximum permissible amount based on the experience of the radium dial painters. The actual measurement of breath radon content requires specialized apparatus and the determination is carried out in only a few laboratories in the country. However, the National Bureau of Standards performs such analyses at a moderate cost. Samples of urine or breath are taken at various intervals depending on the degree of exposure. Slightly exposed personnel may be sampled yearly while those engaged in actual processing may be sampled quarterly. In a few cases where the exposure is to highly toxic substances such as plutonium, urine analysis may be performed more frequently. The over-all evaluation of radiation exposure to plant personnel must include all the possible factors. For example, if there is total body external irradiation, radiation from inhaled or ingested isotopes and surface irradiation of the hands when handling isotopes, it is necessary that the sum of these exposures does not exceed the maximum permissible level. It is not sufficient that each individual factor does not exceed the level set when it is considered to be the only exposure. Such a summation can be a complicated calculation. However, a reasonable approximation can be made, relatively simply, by taking the percentage of permissible level represented by each exposure and summing them up. If they are less than 100 percent the total exposure should be acceptable. Overexposures are handled according to their severity. Where a weekly dose is excessive, it should be possible to maintain the 13-week summation below the permissible level by reducing subsequent exposure, or if necessary by removing the individual entirely from possible exposure. Any exposure greater than that which can be treated in this way is serious enough so that the U.S.A.E.C. rule for radiation protection as well as any applicable state or local rules will require notification of such an occurrence, the reason for it, and procedures instituted to prevent recurrence. Whenever overexposure occurs, the source must be located by a thorough survey. The source must be removed and adequate safeguards set up to prevent recurrence. It should be noted here, however, that no system of rules and safeguards can completely protect careless or ignorant individuals. Therefore, considerable stress must be placed on training the worker in safe practices.

Water and Wastes. Since a radiation protection program includes prevention of exposure of those outside the plant as well as plant personnel it is necessary to monitor plant effluents and wastes before they can be disposed of through the usual channels. The levels of activity permitted in waste materials are quite low and direct measurement with survey instruments is not usually accurate enough to be adequate. In most cases, only a very few isotopes can possibly be present. Thus samples of the waste material can be put through relatively simple chemical separations to isolate a particular isotope from the bulk of the material and to prepare it in a form suitable for counting. A few simple cases may be handled by merely concentrating the isotope, for example, by evaporation of waste solutions or by ashing of combustible solid wastes. Where the isotope is a gamma emitter, these concentration procedures may be perfectly adequate, but for beta emitters, particularly those of low energy, the sample bulk may absorb a large fraction of the emitted particles. Then it is necessary to resort to some form of chemical separation. The chemi-

Table 6. Film Sensitivity

The following table shows sensitive ranges of photographic emulsions. The values given are based, except as noted, on a maximum useful optical density of 3.0 as obtained with Kodak developer. This table is abbreviated from NBS Handbook 51 (6). r = roentgens of x- or gamma-radiation

Emulsion	Useful Range (r)
Eastman type A	0.05 to 1.0
Dupont 508	0.015 to 5.0
Dupont 552 (sensitive)	0.1 to 5.0
Ansco Non-Screen	0.1 to 2.0
Ansco Super-Ray	0.2 to 3.0
Dupont 552 (insensitive)	0.5 to 20.0
Defender Adlux	5 to 1000
Dupont 605	10 to 250

cal methods required for such analyses are all written up in the unclassified (non-secret) literature and are easy to obtain. The sampling process is frequently much more complex, particularly where the wastes are not homogeneous. For this reason, many installations where only small amounts of wastes are accumulated do not bother with sampling or analysis, but treat all such material as contaminated and dispose of it by appropriate methods.

Film Monitoring. Dental x-ray film packets such as DuPont 552 (2 sensitivities), Eastman Type A, or Ansco Non-Screen film are suitable for personnel monitoring. The packets should be purchased in lots sufficient to last three to four months and stored at about 60°F to retard deterioration. The processing of such films requires careful control of development. A contrast developer, such as Eastman Kodak D-19, gives a suitable image with a 3-minute developing time. Both time and temperature should be accurately controlled to insure reproducible results. Development should be stopped with 5 per cent acetic acid or commercial short-stop and the film fixed in x-ray fixer for about 10 minutes. If the films are to be kept as records, they should be washed in running water for at least 30 minutes and thoroughly dried. Processing equipment is available from dental supply houses and film handling is greatly simplified if such equipment is used.

Identification of each film with the individual wearing it is an absolute necessity. Most large installations use a low power x-ray machine and a numerical system to identify each film. This may also be done with an embossing number stamp. When small quantities are used the film may be merely numbered on the outside of the packet before wearing and the individual films kept track of by their position during processing.

The blackening on the dried film must be measured to evaluate radiation. Several film densitometers are manufactured for this purpose. The densitometer readings may be converted to dose units by comparison with a calibration curve prepared by exposing film from the same batch to known amounts of radiation and processing them at the same time as the film from the monitoring procedure. The simplest calibration procedure is to expose the films at various distances from a radium or Co^{60} source of known dose rate. This calibration is exact only if the same isotope is the source of personnel exposure as well. However, it is a good approximation for most other sources and has become the standard for film calibration.

Table 6 shows the useful range of the films mentioned when developed in Kodak D-19 developer.

Instrument Calibration. Laboratory pulse counters must be calibrated with a known source which is the same isotope as that to be measured. All of these counters are sensitive to differences in energy of the particles or rays and suitable calibration standards must be available for each isotope measured. If accuracy is not required, counters may be standard-

Table 7. Calculated Gamma Radiation Levels* for One Curie of Some Radioisotopes

Isotope	Half Life	r/hr at one foot	r/hr at one meter**
Na^{22}	3.0 yr	14.1	1.31
Na^{24}	14.8 hr	20.6	1.92
Mn^{52}	6.5 d	20.8	1.93
Mn^{54}	310 d	5.22	0.485
Fe^{59}	44 d	7.0	0.651
Co^{58}	60 d	6.02	0.560
Co^{60}	5.2 yr	14.3	1.33
Cu^{64}	12.8 hr	4.52	0.42
Zn^{65}	250 d	3.22	0.30
As^{76}	26.8 hr	5.81	0.54
Br^{82}	36 hr	16.1	1.50
I^{128}	25 min	0.194	0.018
I^{130}	12.6 hr	13.5	1.25
I^{131}	8.0 d	2.54	0.236
Au^{198}	2.69 d	6.26	0.583
Radium in equilibrium (0.5 mm Pt filtration)		9.04	0.84

* For an unshielded point source except as noted.
** Values taken from Nuclear Science Series Preliminary Report (7).

ized with a single standard such as the Ra D + E discs prepared by the National Bureau of Standards.

Survey instruments should be calibrated in terms of the particular radiation which will be present in the actual operations. However, it is standard practice to calibrate such instruments in terms of the gamma radiation from a radium or Co^{60} source. This same source may also be used for film calibration. Radium and cobalt sources are prepared in terms of rhm units; that is roentgens per hour at a distance of 1 meter. Other dose rates may be obtained by varying the distance between the source and the instrument.

Table 7 gives the rhm values for 1 curie of various isotopic sources, illustrating the possible differences between sources.

Radium calibration sources in themselves present an additional hazard over that of their gamma radiation. The powdered radium salts are enclosed in a platinum or a glass and platinum capsule. If the capsule should become ruptured by accident, a considerable quantity of alpha emitting material may be released. Cobalt sources, on the other hand, are solid metallic material and are not subject to rupture. Their only disadvantage is the change in their activity with time—the Co^{60} decaying with a half-life of 5.2 years.

Area Surveying. Area surveys are carried out with a portable dose rate survey meter sensitive to the radiation present. General area surveys for beta and gamma radiation are best performed by holding the detector away from the body at waist level and tracing a systematic path through the area, noting any rise in radiation level and marking these spots either directly with chalk or on a diagram. Radiation levels above the permissible level require immediate cleaning or supplementary shielding and re-surveying until the level is reduced to acceptable limits. Levels markedly above background but below the permissible level may be attacked in a more leisurely manner.

Surface contamination with alpha or beta emitters can also be surveyed by moving the detector slowly over a systematic path covering the floor, walls, and working surfaces. Areas indicating contamination well above background may be checked with a wipe test as described in the discussion on surface contamination.

Permissible radiation levels are set up based on the dose received above that received from the radiation that is normally present. This background radiation is variable and it is necessary that it be considered when surveying work areas. Background level can best be measured with the actual instrument used for the survey in a spot well away from the work area. Values ranging from 0.01 to 0.05 mr/hr are quite common and the background may be even higher in geographical areas where large deposits of radioactive elements are found.

Responsibility

The responsibility of the supervisor of work with x-ray equipment or with radioisotopes is perhaps even greater than that of a supervisor in charge of dangerous chemical operations. The immediate effects of most chemical accidents are fully appreciated and, usually, the chemical agent can be neutralized or destroyed to prevent further exposure. This is not true for radiation or radiation emitters, and the lack of immediate effect makes supervisory control more difficult.

In considering the handling of reasonably long-lived isotopes, it must be realized that responsibility involves being certain not only that the workers who handle the material are not overexposed, but also that none of the material escapes to endanger others.

All instruction designed to minimize the radiation exposure of plant workers should originate with the technically qualified man in charge. Most of the attention must be directed to give the operating supervisors a complete picture of the nature of the hazards, the ways in which the resulting exposures can be minimized, and the value of the monitoring and control procedures to be used. Depending on the size of the organization and the quality of the personnel, this same instruction may be given to all workers or else the complete responsibility may be given to the operating supervisor. In any case, the workers should know that they are being exposed to radiation, the steps being taken to protect them from overexposure, and the safety regulations which are made necessary by the nature of radiation. It is sometimes difficult to teach safe practices without causing an excessive alarm in some people but the fear of such alarm cannot be used to justify withholding such information.

The paragraph below will show the responsibility of supervisory personnel to the various groups under their control, as well as to those outside the plant. Management, operational supervisors and technical personnel must all play a part in minimizing radiation exposure.

Workers. The most immediate responsibility of management is to the workers directly concerned with radiation. Responsible persons must see that the exposure of the workers is continuously evaluated, that records of their exposure are maintained, and that continued overexposure is not allowed. With a group of non-technical personnel this responsibility can best be delegated to the operation supervisor. From his other duties, he is familiar with the operations and personnel and is able to issue direct orders. It is not necessary that he be completely trained in the technical aspects of radiation protection, but rather that he understand the measurements made and the meaning of the numbers obtained. In addition, there must be someone available to give technical advice on radiation protection problems. While a large organization may have its own radiation safety officer or similarly qualified person, the smaller organization may have to depend on consultants in the field. In either case, the direct day-to-day supervision can best be handled through the operational supervisor or a radiation safety supervisor. When the phrase "technically qualified person" is used, it may be defined as in the National Bureau of Standards Handbook 41 (8) as a "person having the knowledge and training needed to measure radiation and to advise regarding radiation hazards." In technical groups, such as laboratories or hospitals, there is still need for someone to have charge of records and to perform the duties of an operational supervisor. This person must have the authority to issue direct orders concerning exposure. Almost all of the recorded cases of radiation overexposure have been to technical personnel who knew the hazard and ignored the possible consequence. Management is still responsible for the actions of these employees. To protect the workers and themselves, they must set up an adequate supervisory system and follow the records to see that the program is being carried out. Those working directly with radiation will have the highest potential exposure and must be given the most attention in a radiation protection program. This must include exposure evaluation, exposure records and job training to minimize hazards.

All other employees may be split into two classifications: those who enter the work area for relatively short periods, such as maintenance workers, and those who do not enter the area. In an operation involving low radiation levels exposure can be considered negligible if that of the direct workers is well below the maximum permissible levels. In any case, casual visits to the work area should be minimized in length and cut to a very small number by proper planning. If the radiation level in the work area is higher, it becomes necessary to include anyone entering the work area in the complete control program of personnel monitoring and exposure records. In a large organization this can become a matter of considerable expense, but again, by careful planning, the number of these casual visitors can be kept to a minimum. The casual worker in the operating area has the added disadvantage that he is not fully acquainted with the operations or the hazards involved and may do something which may expose him to more radiation than someone familiar with the operations. The supervisor for the area is responsible for the safety of these part-time workers and must either supervise their activities or instruct them in the safety procedures of the area. Employees outside the work area must receive only a minimum exposure and this is the responsibility of the technically qualified person in charge. Generally, minimizing such exposure is accomplished in the original design of the installation, but periodic checks of the operation of control measures must be made. Personnel monitoring should not be required, as any design which would allow a measurable exposure outside the work area is entirely unsatisfactory, and no operations should be carried out in such an area.

Neighborhood. Minimizing the hazards of exposure to persons in the neighborhood of the plant is the responsibility of the qualified technical man in charge. Direct radiation should not be a hazard; the problems are rather those of radioisotope waste disposal. Periodic checks of contamination of the neighborhood must be made and, if the level of activity handled in the installation increases, continuous monitoring may be required. The permissible levels of exposure for plant personnel are not satisfactory for those living or working in the neighborhood. All plant workers must realize the hazards involved in their jobs, and in accepting a job accept the hazards. This is true in any field and is not unique for those engaged in work with radiation. People outside the plant are not aware of the hazards and have not entered into any agreement with the company. Therefore, every effort should be made to see that their possible exposure is far below that allowed for plant personnel. The limitation of exposure for those under 18, given in NBS Handbook 59 (5) as one-tenth of that for adults, is an indication of the levels sought. The responsibility to those even more remote from the work area is one of reducing the possible build up of the world-wide radiation level through careless handling of wastes. Although procedures for waste handling may originate with the technically qualified man in charge, responsibility for carrying out these procedures must rest directly on the operating supervisor.

Radiation Control

A radiation protection program has two facets, the continuous evaluation of exposure, and the reduction of exposure by any applicable control measure. The fact that all exposures are maintained below maximum permissible levels is an indication that the control procedures are working, but since any unnecessary exposure is foolish, the possibility of maintaining values as low as possible should be continuously kept in mind.

A major factor in control is the proper training of operating personnel. It is part of supervisory responsibility that every worker know what he is working with, what the hazards are, and what measures are being taken to secure his safety. He must be trained in safe techniques and know what to do in case of an accident. And he must be made to realize that observance of safety rules and personnel monitoring requirements are just as much a part of the job as the actual operations performed.

At the present time radioisotopes are available only through the Atomic Energy Commission. This means that a certain degree of control is exercised in the allocation of isotopes. Applications are reviewed by the AEC and applicants are required to describe the purpose for which the isotopes are to be used and the facilities and equipment available for radiation protection. The applicant agrees to keep records of the receipt, use, and distribution of the isotopes and further agrees not to use them for purposes other than those described or even to redistribute the materials to others without authorization. The measurement and evaluation of exposure have been discussed previously; the following discussion will introduce the various methods of reducing radiation exposure.

Reducing Exposure. The three methods of reducing radiation exposure are: (1) increasing shielding, (2) decreasing the time of exposure and (3) increasing the distance between worker and source. In the usual x-ray or isotope installation the shielding is part of the original design, but modifications of equipment or changes in operating technique may require shielding changes. Such shielding is subject to the same criteria as that in the original design and will be covered later. The actual physical setup may vary however, if only temporary shielding is required. Temporary shielding is set up with interlocking lead bricks or steel plates of the proper thickness. Such shields can be readily assembled or stored when no longer needed. If these temporary shielding materials are made easily available in the work area they will be used more often.

Reducing the time of exposure is not just a matter of calculating the permissible time in a certain area which will keep the exposure at the maximum permissible level. Exposure time should be reduced to the minimum consistent with sound economical operation. This can be facilitated by careful planning of procedures. In a practical sense this means that isotopes should be kept in shielded containers when not in actual use, x-ray workers should not enter any area where measurable scattering from x-ray equipment occurs except when absolutely necessary, and all those not directly concerned with an immediate operation should be excluded from the irradiated area. Again, these steps are not taken merely to maintain exposures below maximum permissible level but to keep over-all exposure to a minimum.

One method of reducing exposure time which may be applicable in some instances is rotation of personnel. The operators or technicians may be trained to interchange jobs, and the higher exposure operations rotated over the longest possible period.

The factor of distance is probably the most valuable means of controlling radiation exposure. It has been emphasized indirectly in the preceding paragraph in that those not directly concerned with the operation should be excluded from the work area and also that operating personnel should stay away from radiation sources when their presence is not required.

Radiation intensity decreases according to the inverse square law; that is, doubling the distance drops the exposure rate to 1/4, tripling the distance, to 1/9, and so on. This rapid fall off with distance can be of greatest assistance when properly used. It is certainly the cheapest barrier to overexposure.

Actual work areas where the possible exposure approaches permissible levels should be posted with signs indicating the level of radioactivity, and whenever possible, temporary barriers should be set up to keep those not working directly with the radiation source at a safe distance.

When handling isotopes, various personnel protection equipment may be required. Depending on the activity level and the physical state of the active material, coveralls, gloves or respirators may be required. This will be discussed further in connection with decontamination. In cases where heavy beta exposure is possible, it is sometimes advisable that the workers wear heavy-lensed goggles to reduce eye exposure.

Decontamination. Isotope spills may occur and prompt decontamination is necessary to minimize exposure. This is not only required for the reduction of direct radiation but to prevent spilled material from becoming air-borne or being picked up by contact. The supervisor and preferably the workers as well should know the proper means of cleanup for any possible isotope spill in the operations which they are performing. When an accident occurs the operator should move to a safe distance and call for assistance. The greatest difficulty with spills in the past has been that the workers, scientifically trained or not, try to clean up and end up spreading contamination throughout the laboratory or plant. The first operation in decontamination is to check the personnel to see if their clothing or bodies have become contaminated. This should be done by the supervisor or technically qualified person. If the workers are not contaminated, they may proceed with the area clean-up.

The maximum permissible levels of skin contamination are as follows:

(a) Spot skin contamination with isotopes of Group I or II of Figure 2 (p. 87) should be less than 1 mrep per hour for any 2 square inch area.

(b) Spot skin contamination with isotopes of Group III should be less than 0.1 mrep per hour.

(c) General body contamination with any isotope should be less than 0.1 mrep per hour.

If it is found that the workers are contaminated, their clothing should be removed and their bodies checked for radioactivity. Any active areas should be washed with plenty of water. Decontaminating agents are not always satisfactory for application on skin. Two agents recommended in the National Bureau of Standards Handbook 48 (9) are titanium dioxide paste or a saturated solution of potassium permanganate followed by a 5 per cent sodium bisulfite solution rinse.

The following detailed directions for these decontamination procedures are taken from NBS Handbook No. 48 (9).

(1) Apply a liberal portion of titanium dioxide paste to the hands. Work this paste over the affected surface and adjacent areas of the skin for at least 2 minutes. Use water, sparingly, only to keep the paste moist. Rinse with warm water, and follow by thorough washing with soap, brush, and water. Be sure that no paste is allowed to remain around the nails. Monitor. Repeat the entire process if necessary. It should be noted that the condition of the titanium dioxide paste is very important. In order to be effective, the paste must be prepared by mixing precipitated titanium dioxide (a very thick slurry, never permitted to dry) with a small amount of lanolin.

(2) *Part A.* Mix equal volumes of a saturated solution of potassium permanganate and 0.2N sulfuric acid. Pour this over the wet hands, rubbing the entire surface and using a hand brush for not more than 2 minutes. *Note:* This application will remove a layer of skin if allowed to remain in contact with the hands too long; consequently, the time stated here should

not be exceeded for any single application. Be sure that all areas are thoroughly covered. Rinse with warm water and proceed as follows:

Part B. Apply a freshly prepared 5 per cent solution of sodium acid sulfite ($NaHSO_3$) in the same manner as above, using a hand brush and tepid water for not more than 2 minutes. Wash with soap and water, and rinse thoroughly. The above procedure may be repeated several times as long as the permanganate solution is not applied for more than 2 minutes during any one washing. Applications to other parts of the body than the hands may be facilitated by the use of swabs steeped in the solutions. Lanolin or hand cream should be applied after washing.

Note: A hand decontamination kit should be maintained in each wash room associated with laboratories in which work is done with radioisotopes.

If a significant quantity of radioactive material has been ingested, the treatment should follow that given for general chemical poisoning such as dosing with an emetic. Introduction of hazardous quantities of radioisotopes into a puncture wound or cut requires immediate action. The injury should be washed with large amounts of water and treatment similar to that for snake bite given immediately afterward.

The problems of skin contamination, ingestion and entry through wounds have been mentioned. However, it must be remembered that these are treatments where possible toxic quantities of material are present. If small quantities of isotopes are being handled, there is no point in using drastic means of first aid when an accident occurs. It is the responsibility of the operational supervisor to know whether an accident can be a source of hazard and what procedures should be followed in the event of an accident.

The reason for immediate action in area decontamination is to prevent the spread of radioactive material. The return of the area to operating condition is usually not a critical factor and the cleanup can proceed in an orderly, planned fashion. All cleaning should be from the outer part of the area working in toward the center of contamination. The operation should be monitored for personnel overexposure and to check that contamination is not being spread. In most cases a preliminary washing with water and detergent will remove the majority of the isotope. After that smaller areas may be cleaned up with decontaminating agents suitable for the isotope and the surface to be cleaned. Table 8 lists decontamination methods recommended by the Federal Civil Defense Agency.

Table 8. Decontamination Methods*

Surface	Method	Advantages	Disadvantages
Paint	Water	Most practical method of gross decontamination from a distance. Contamination reduced by approximately 50 per cent.	Protection needed from contaminated spray. Runoff must be controlled. Water under high pressure should not be used on a surface covered with contaminated dust.
	Steam (with detergent if available.)	Most practical method for decontaminating large horizontal, vertical, and overhead surfaces. Contamination reduced by approximately 90 per cent.	Same as for water.
	Soapless detergents	Where effective, reduces activity to safe level in 1 or 2 applications.	Mild action.

Table 8. Decontamination Methods* (continued)

Surface	Method	Advantages	Disadvantages
Paint (cont.)	Complexing agents: oxalates, carbonates, citrates.	Holds contamination in solution. Contamination on unweathered surfaces reduced by approximately 75 per cent in 4 minutes. Easily stored, nontoxic, noncorrosive.	Requires application from 5 to 30 minutes for effectiveness. Has little penetrating power; hence of small value on weathered surfaces.
	Organic solvents	Quick dissolving action makes solvents useful on vertical and overhead surfaces.	Toxic and flammable. Requires good ventilation and fire precautions.
	Caustics	Minimum contact with contaminated surface. Contamination reduced almost 100 per cent.	Applicable only on horizontal surfaces. Personnel hazard. Not to be used on aluminum or magnesium.
	Abrasion (wet sand-blasting	Complete removal of surface and contamination. Feasible for large-scale operations.	Contaminated sand spread over large area. Method too harsh for many surfaces.
Metal	Water	Contamination reduced by approximately 50 per cent.	Same as for painted surfaces.
	Detergents	Removal of oil or grease films	Same as for painted surfaces.
	Organic solvents	Stripping of grease	Same as for painted surfaces.
	Complexing agents; oxalates, carbonates, citrates.	Holds contamination in solution.	Difficult to keep in place on any but horizontal surfaces. Limited value on weathered porous surfaces.
	Inorganic acids	Fast, complete decontamination.	Good ventilation required; acid fumes toxic to personnel. Possibility of excessive corrosion. Acid mixture cannot be safely heated.
	Acid mixtures.	Action of weak acid. Reduces contamination of unweathered surfaces.	Same as for inorganic acids.
	Abrasion (buffers, grinders)	Useful for detailed cleaning.	Follow-up procedure required to pick up powdered contamination.
	Abrasion (wet sand-blasting)	Same as for painted surfaces.	Same as for painted surfaces.
Concrete	Abrasion (vacuum blasting)	Direct removal of contaminated dust.	Contamination of equipment.

Table 8. Decontamination Methods* (continued)

Surface	Method	Advantages	Disadvantages
Concrete (cont.)	Vacuum cleaning	Same as for vacuum blasting on concrete.	Same as for vacuum blasting on concrete.
	Flame cleaning	Only method of trapping contamination on surface.	Slow and painstaking. Fire and air-borne radiation hazard is great.
Brick	Same as for concrete	Same as for concrete.	Same as for concrete.
Asphalt	Abrasion	No direct contact with surface; contamination may be reduced to safe level.	Residual contamination fixed into asphalt. If road is subject to further contamination, may require recovering.
Wood	Flame cleaning	Same as for flame cleaning on concrete.	Same as for flame cleaning on concrete.

Notes

1. Another complexing agent would be a solution of 1% ethylene diamine tetra-acetic acid ("Versene", "Sequestrene") in water.

2. Oxalates, carbonates or citrates may be the ammonium or sodium salts.

3. Caustics should preferably be trisodium phosphate or sodium sesquicarbonate rather than hydroxides since they are less hazardous.

* "Radiological Decontamination in Civil Defense" (10).

The maximum level of radiation which is frequently recommended is 0.1 mrep per hour for large surfaces. While this may seem to be a very low level it is not impossible to attain, and maintenance of contamination below this value will keep the general level of the work area within satisfactory limits.

The decontamination procedure should be followed with survey instruments and the working area should not be reopened for operations without the approval of the qualified technical person in charge. If the quantity of isotope involved in the accident is at the toxic level, the cleanup crew should wear gloves and other protective clothing. Any possible air-borne contamination makes necessary the use of respirators. When the clean-up procedure is completed, the bodies of the crew should be monitored, after removal of their protective clothing, and any radioactive material on the body removed as described above.

Ventilation. Ventilation is needed only when dealing with isotopes that may become air-borne. This can happen much more readily than is commonly imagined, since transfer of dry solids, boiling of liquids or other normal processes frequently give rise to air-borne contamination. Such operations should be carried out in well ventilated areas only and monitoring of the level of air-borne activity must be a part of the protection program. This is true only if the total amount of isotope handled is possibly toxic; it is not required for lower levels of activity.

General ventilation requirements for the handling of toxic materials are covered in Section 2. The general requirements apply as well to handling radioactive materials. The only additional factor to consider is that hoods for use with isotopes emitting penetrating radiation also require shielding. This shielding may disturb the air flow characteristics of the hood and measurements of air flow should be made before any operations are carried out to insure adequate ventilation. Almost all operations involving small amounts of isotopes can be carried out in a totally enclosed hood or dry box. The dry box is set up so that the worker performs all operations through gloved ports. The ventilation intake is at the ends of the box and the outlet at the rear or top is connected to suitable ducts. Such a totally enclosed system offers a great margin of safety while a small amount of practice allows normal operations to be carried out with facility.

Personnel Contamination. The hazard from radioisotopes taken internally has been described earlier in this section and in Section 10. Actually, effective prevention of isotope ingestion depends on the personal habits of the worker. The common preliminary to ingestion is transfer of activity from contaminated surfaces or objects to the mouth by way of contaminated hands, food, etc., when eating or smoking. It is an absolute requirement for laboratories handling unsealed isotopes that edible materials should not be allowed into the work area. The general spread of contamination by hands to personal clothing and personal items such as pocketbooks can only be stopped by frequent hand cleaning, particularly before leaving the work area. This cannot readily be a supervised process, but whenever dangerous quantities of isotopes are handled, the workers must be explicitly instructed in the requirements of personal cleanliness and good housekeeping.

The requirement for protective clothing in isotope handling depends on the level of activity handled. At any level of activity, it is desirable that street clothing should not be worn in the plant or laboratory. Nor are laboratory coats good protection for prevention of contamination. Actually, when levels above tracer quantities are handled in such a way that contamination can occur, a change room should be provided with separate lockers for street and work clothing and with adequate shower and scrubbing facilities. (At this same level, the laundering of work clothing should be done at the site. Contaminated clothing should not be sent to commercial laundries.)

Rubber gloves are a very good means of preventing the spread of radioactivity by the hands. Some delicate manual operations may require surgical gloves, but whenever possible cloth-lined heavy gloves should be worn. These should never be removed from the work area until ready for disposal. More specialized equipment such as rubbers, overshoes or shoe covers are rarely required, unless serious floor contamination has occurred.

Re-Evaluation. A radiation control program is almost useless unless it is continuously re-evaluated. Many changes can take place without being apparent. Shields may develop cracks or other openings, spills of radioisotopes may cause contamination in an unexpected part of the work area, ventilation blocks may occur or some change in operating technique may present a new source of radiation. Therefore, a re-evaluation of the control system must be made periodically. A portion of this is done through the personnel monitoring program, but surveys with portable instruments can be of great value in detecting sources of radiation before they appear in the results of personnel monitoring. This concept is true of many types of health protection. No control program can be considered as completely static and free from the possibility of breakdown.

Design of Radiation Control Installations. The design of an installation where radiation exposure is possible is probably the most important single factor in maintaining low exposure levels. The addition of radiation control measures to an operating laboratory or plant is always more expensive and usually less effective than when control measures are built into the original design. The various factors of responsibility must be included when designing a work area and a complete knowledge of the processes to be carried out in the area must be available to the designer. Redesign may be necessary if the quantity of isotopes or the x-ray energy is increased since this adds very considerably to the cost. Suitable protection for the visible future should be part of the initial plan.

One factor in laboratory design which lies outside the field of direct radiation protection is the requirement that radiation measuring equipment be installed in areas which have low radiation background and which are not easily subject to contamination. Counters and other equipment are efficient only when the ratio of background to the desired activity is maintained at a low level. This usually requires isolation or shielding of the measuring area beyond the requirements for eliminating health hazards.

Type of Installation. Installations where radiation is a hazard may be classed according to whether the source of radiation is electrical, such as x-ray equipment, or radioisotopes. Under the classification of x-ray operations we have medical units for diagnosis and therapy and industrial units for testing of products as well as laboratory equipment for x-ray diffraction and other scientific measurements. The isotope field may be divided into laboratory installations using isotopes for experimental purposes and industrial operations such as radiography. The large-scale utilization of low priced isotopes, such as mixed fission products, for sterilization of foods or drugs or similar process is still in the early development stages.

Medical X-ray Installations. The medical x-ray technician and radiologist have given less consideration to their safety precautions than anyone else with hazardous exposure. Most of our knowledge leading to the setting up of permissible levels came from overexposures incurred in the medical use of x-rays. It is also probable that many patients received excessive exposures in the course of diagnosis. X-ray therapy is always a calculated risk, where the possible damage from the high x-ray dose is balanced against the possible effects of the disease. Here again it is probable that the hazard has not been given full weight in decisions to use extensive x-ray therapy.

The basic criterion for x-ray operation is that the radiologist or technician not receive more than the maximum permissible dose. Reduction of dose rate can best be accomplished by proper design of the installation. *The x-ray machine should have inherent shielding to reduce the dose rate to below 0.1 r/hr at one meter,* so the two sources of exposure are the useful beam from the x-ray tube and scattered radiation from the patient and the four walls and ceiling of the room. It is not possible to shield the useful beam, although 1 millimeter of aluminum will assist in removing the low energy x-rays which are of little value yet present considerable biological hazard. The useful beam, of course, must also be prevented from leaving the room and exposing those outside the x-ray installation. The requirements for lead, iron, and concrete shielding vary for beams of various energies and intensities as well as the distance between source and shield.

A barrier for containing the direct beam may be designed from the data in Tables 9, 10, and 11, taken from NBS Handbook 50(11). It is apparent that extending this barrier to the floor, ceiling and all walls would be extremely expensive, both for the shielding material itself and for suitable building construction to support such a weight of shielding. Therefore, it is more economical mechanically to limit the direction in which the beam can be pointed. If this is done, a primary barrier is only required to cover the field which can be intercepted by the useful beam.

All other walls and the floor and ceiling must have suitable secondary barriers to absorb scattered radiation plus leakage radiation through the tube shield if the area on the other side of the shield is inhabited. These secondary barriers are computed on the basis that the scattered radiation is 0.1 per cent of the primary beam at a distance of 1 meter from the scatterer.

The shielding for other currents than 10 ma for the potentials shown in Tables 9, 10, and 11 may be computed from the half-value layer (HVL). For example, a target current of 5 ma at 100 kv for a target-to-operator distance of 10 feet would give only one-half the intensity of the 10 ma beam. Thus the barrier may be reduced by one HVL. The table value

Table 9. Primary Protective-Barrier Requirements for 10 Milliamperes at the Pulsating Potentials and Distances Indicated

Target Distance ft	Lead Thickness with Peak of				
	75kv mm	100kv mm	150kv mm	200kv mm	250kv mm
2	2.2	3.4	4.3	6.7	11.8
3	2.0	3.1	4.0	6.2	10.9
5	1.7	2.7	3.6	5.5	9.6
8	1.5	2.4	3.2	4.8	8.5
10	1.3	2.2	3.0	4.5	8.1
15	1.1	1.9	2.6	4.0	7.1
20	1.0	1.7	2.4	3.6	6.4
50	0.5	1.1	1.7	2.4	4.3
Approximate HVL thickness measured at high filtrations	0.18	0.24	0.3	0.5	0.8
Radiation filter (mm of Al)	0.5	0.5	3.0	3.0	3.0

Table 10. Primary Protective-Barrier Requirements for 500 Kilovolt Constant Potential with Transmission Target

Target Distance ft	Barrier Thicknesses with Target Current of					
	1 ma		3 ma		5 ma	
	Lead mm	Concrete* in.	Lead mm	Concrete* in.	Lead mm	Concrete* in.
5	36	18.0	42	20.5	44	21.5
8	31	16.0	37	18.5	39	19.5
10	29	15.0	35	17.5	37	18.5
15	25	13.5	31	16.0	33	17.0
20	22	12.5	28	14.5	30	16.0
50	14	8.5	19	11.1	21	12.0
100	8	6.0	13	8.0	15	9.5
Approximate HVL thickness measured at high filtration			3.0	1.5		

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* The density of this concrete is 147 lb/ft^3.

Table 11. Primary Protective-Barrier Requirements for 1,000 Kilovolt Constant Potential with Transmission Target

Target Distance	Barrier Thicknesses with Target Current of					
	1 ma		3 ma		5 ma	
	Lead	Concrete*	Lead	Concrete*	Lead	Concrete*
ft	mm	in.	mm	in.	mm	in.
5	123	30.5	131	32.5	136	33.5
8	113	28.0	120	29.5	125	30.5
10	107	27.0	115	28.5	120	29.5
15	97	24.5	105	26.5	110	27.5
20	91	23.0	99	25.0	103	26.0
50	69	18.5	77	20.5	82	21.0
100	53	15.0	61	17.0	66	18.0
Approximate HVL thickness at high filtration			8	1.8		

---

* The density of this concrete is 147 lb/ft^3.

of 2.2 mm for 10 ma may be reduced by 0.24 mm, giving 2.0 mm for a 5 ma target current. Similarly, a 2.5 ma current would allow reduction by 2 HVL. In practice, the barrier is usually designed for the maximum values of kilovoltage and target current that the x-ray machine can produce and for a full work week.

If the value of 0.1 per cent is accepted for x-ray scattering, the secondary barriers shown in Table 12 should be sufficient for all areas out of the useful beam (5). The current-time factor is for a 4000 ma-min. maximum weekly usage. If other maxima are planned, the values of Table 12 may be adjusted by applying the factors of Table 13.

For example, a 400 kvp x-ray machine would require (from Table 12), a lead barrier of 6.6 mm at 10 feet. If the total weekly maximum usage were 800 minutes at 3 ma, the current-time factor would be 2400 ma-min. From Table 13, it is seen that the barrier can be reduced by 0.67 HVL, or about 0.5 mm. The final barrier could then be 6.6 less 0.5 or 6.1 mm of lead.

A graphical system for computing barriers is given in Figure 3 (12).

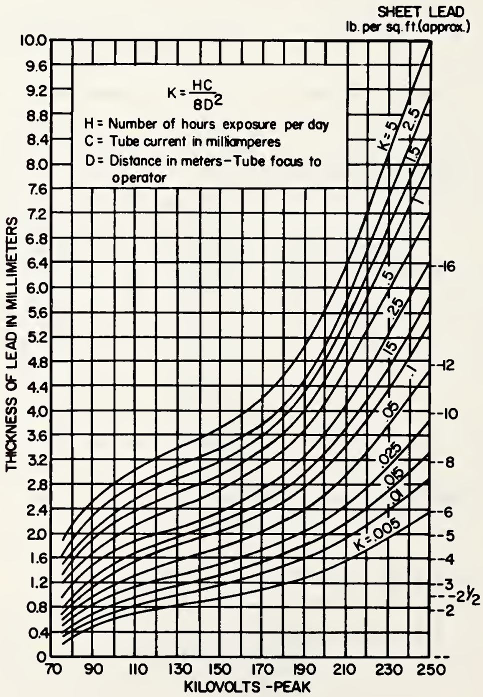

Figure 3. Thickness of Lead Barrier Required to Reduce X-ray Dosage Rate of the Useful Beam to 50 mr per Day Under Indicated Conditions.

Table 12. Secondary Protective Barriers in Thickness of Lead or Concrete Required by Installations Operating at 4000 ma-minutes per Week for Several Tube-to-Protected-Zone Distances*

KVP	HVL		3.5 ft		5 ft		7 ft		10 ft		14 ft		20 ft	
	Lead mm	Concrete in.	Lead mm	Concrete in.	Lead mm	Concrete in.	Lead mm	Concrete in.	Lead mm	Concrete in.	Lead mm	Concrete in.	Lead mm	Concrete in.
75	0.16	0.5	0.6	1.8	0.4	1.2	0.3	0.9	0.1	0.3	0.1	0.2	0	0.1
100	0.18	0.6	0.8	2.4	0.6	2.0	0.5	1.6	0.3	0.8	0.2	0.4	0.1	0.2
150	0.22	0.7	1.3	3.8	1.1	3.3	0.9	2.7	0.6	1.7	0.4	1.1	0.2	0.6
200	0.3	1.2	2.4	6.1	1.9	4.8	1.4	3.5	1.1	2.9	0.9	2.4	0.4	1.1
250	0.5	1.1	3.8	6.8	3.0	5.7	2.2	4.7	1.7	3.7	1.4	2.9	0.6	1.5
400	0.8	1.6	13	9.5	11	8.0	8.6	6.5	6.6	5.0	4.6	3.5	2.8	2.5
500	2	1.5	19	11	16	9.0	13	7.8	10	6.3	6.9	4.8	4.0	3.0
1000	3	1.4	56	17	48	16	40	14	32	13	24	11	19	7.5
2000	8	1.4	--	20	--	19	--	17	--	16	--	15	--	13

* The barriers shown are sufficient for both leakage and scattered radiation provided the minimum tube-to-scatterer distance is 50 cm and the leakage radiation at one meter from the tube does not exceed the following: 75 to 150 kvp at 5 ma — 0.1 mr per hour and 200 to 250 kvp at 15 ma, 400 to 500 kvp at 5 ma, 1000 kvp at 3 ma, 2000 kvp at 2 ma — 1.0 mr per hour.

Table 13. Number of Half Value Layers by Which Secondary Protection Barriers May Be Increased or Decreased When Operational Requirements Differ From 4000 ma-min.

ma-min.	No. of HVL
500	− 3.00
1,000	− 2.00
1,500	− 1.41
2,000	− 1.00
2,500	− 0.67
3,000	− 0.41
4,000	0.00
5,000	+ 0.33
6,000	+ 0.59
8,000	+ 1.00
10,000	+ 1.33
16,000	+ 2.00
20,000	+ 2.33
32,000	+ 3.00
40,000	+ 3.33
50,000	+ 3.67

For convenience, a chart of lead equivalents is also given in Figure 4 since computations give lead thickness in mm or inches, while manufacturers specify pounds per square foot. Our previous example for the direct beam barrier for 5 ma at 100 kv and a distance of 10 feet would give

$$K = \frac{HC}{8D^2} = \frac{5}{(3.05)^2} = 0.54$$

From the chart, we find a thickness of 2.0 mm, which is in agreement with the value from Table 9*.

The operator of such equipment might possibly receive an excessive dose from scattered radiation. This may be reduced somewhat by wearing protective clothing but this method is certainly not reliable.

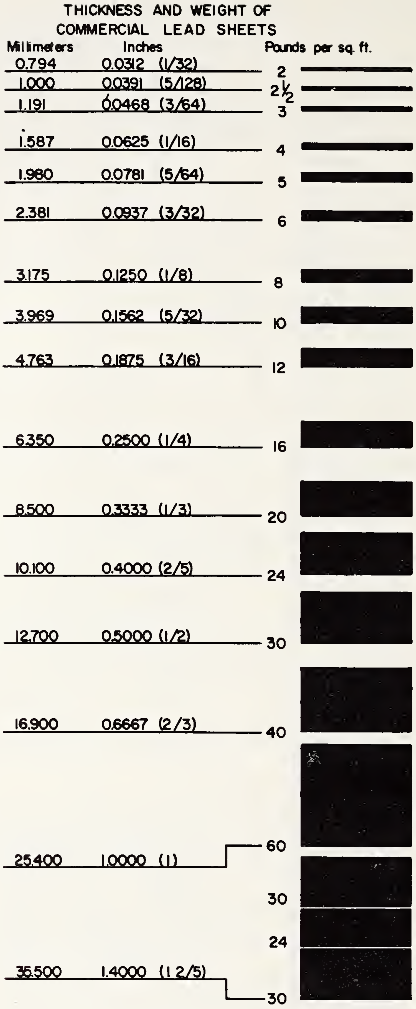

Figure 4

It is much better to include a shielded booth for the operator in the original design. A proper design would require that the operator be in the booth in order for the x-ray equipment to operate. Thus, after placement of the patient, he would enter the booth and begin the exposure. While automatic timers are desirable they may fail and the presence of an operator at all times will insure that the patient does not get an excessive dose. The patient may be observed through lead glass windows.

The installation described is one step away from the so-called totally protected system. Such a system includes electrical inter-locks so that it is impossible for the x-ray unit to

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*Detailed barrier calculations, particularly for secondary shielding, may be found in NBS Handbook 50 (11).

Table 14. Concrete Barrier Requirements for 2000 kv X-rays

Target Distance	Concrete thicknesses* with target current of		
	0.5 ma	1.0 ma	1.5 ma
ft.	in.	in.	in.
5	42.5	45.0	46.5
8	39.5	42.0	43.5
10	38.5	40.5	42.0
15	35.5	38.0	39.5
20	34.0	36.0	37.5
50	28.0	30.0	31.5
100	23.5	25.5	27.0
Approximate HVL thickness measured at high filtration	----	2.3	----

*The density of this concrete is 147 lb/ft^3.

be operated unless everyone is out of the x-ray room with the exception of the patient. Such an installation is most desirable where heavy doses are administered for therapeutic purposes. The less rigid design, requiring only that the operator be at the control panel behind a shield before radiation can begin, is suitable for diagnostic x-ray.

Industrial X-ray Installations. Industrial radiography requirements have brought about the development of higher and higher voltage x-ray equipment. The need for seeking flaws in large castings as well as similar non-destructive tests requires extremely penetrating, high energy radiation. In addition, radiographic equipment is in operation a larger fraction of the time than ordinary medical equipment. Therefore, even more care is required in industrial work than in medical work. One advantage of industrial design is that the direct beam can usually be absolutely fixed in a vertical downward position on the lowest floor of the building and the need for primary shielding can be eliminated (13).

There is no excuse for any industrial installation not using a totally protected system. The operator is dealing with inanimate objects which can be set immovably in place and the exposure must be controlled to produce a usable film. Therefore, the operator should be in a booth where he can control the total exposure without being exposed to either primary or secondary radiation. If the objects to be radiographed are changed by other workers, there must also be an interlock and signal system so that even a careless x-ray operator cannot start the exposure unless everyone is clear of the room.

The high voltage industrial installations usually rely on concrete shielding rather than lead. Tables 10 and 11 gave concrete shields as well as lead, and Table 14 gives the concrete barrier requirements for 2000 kv x-rays.

The high mechanical strength and simple construction of concrete barriers more than compensate for the greater thickness required in comparison to lead. The space requirement can be reduced somewhat with heavy concrete, and these compositions will be described later. There has been some question of the efficiency of concrete shielding for broad x-ray beams, and concrete-lead sandwiches have been used to advantage. No design data are available.

Gamma-Ray Radiography. Isoto-

Table 15. Gamma-ray Shielding with Concrete

Reduction Factor		2	10	100	1000	10^6
Energy of γ-rays	Type of Concrete	ST* in.	ST in.	ST in.	ST in.	ST in.
1 Mev	Plain	3.2	9.3	17.1	24.5	45.6
	Magnetite	2.0	5.8	10.6	15.3	28.3
	Limonite	2.8	8.2	15.1	21.6	40.3
	Limonite + Iron	1.7	5.0	9.2	13.1	24.3
3 Mev	Plain	5.3	15.9	29.8	42.9	81.1
	Magnetite	3.1	9.4	17.5	25.4	48.0
	Limonite	4.7	13.6	25.5	36.9	69.8
	Limonite + Iron	2.6	7.9	15.0	21.5	40.9
5 Mev	Plain	6.8	20.9	39.8	57.9	110.0
	Magnetite	3.5	11.1	21.4	31.3	59.6
	Limonite	5.4	16.9	32.4	47.3	89.9
	Limonite + Iron	2.8	9.0	17.4	25.6	48.8

* Shield Thickness.

Table 16. Composition of Some Plain and Heavy Concretes

Type	Composition (% by Weight)			lb/cu ft
	Water	Cement	Aggregate	
Ordinary	8.4	17.7	73.9	147
Magnetite	5.5	11	83.5	236
Limonite	10.5	21	68.5	164
Limonite + Iron	4.7	9.5	85.8	275

pic sources for industrial or medical radiography are more closely allied to x-ray equipment than to isotopes as used for laboratory purposes. The source must be a gamma emitter of high intensity and usually of high energy. When installed, it is protected by heavy shielding to give a useful beam very close in properties to the useful beam from x-ray equipment and completely encapsulated to prevent escape of the isotope. All of the design criteria for x-ray installations would apply to one using gamma sources for radiography.

The advantages of concrete for shielding are very marked when designing for energetic gamma emitters. Table 15 shows the barrier characteristics of plain and heavy concrete for gamma shielding (14). The composition of the concretes of Table 15 are given in Table 16. Baryte aggregate yields a concrete very similar in its shielding properties to the magnetite concrete shown in Table 15.

Isotope Laboratories. Operations with isotopes that are not encapsulated differ from radiographic operations. They can however, be contained by shielding techniques and the isotopes stored so that no hazardous radiation is possible outside the container walls. Any operation with isotopes offers certain additional hazards over those found with x-ray equipment. First, materials may become airborne, so the external radiation from an isotopic source may be negligible compared with the hazard from its inhalation or ingestion.

Table 17. Gamma-ray Shielding

Activity	Energy (mev)								
	0.2	0.5	0.8	1.0	1.5	2.0	2.5	3.0	4.0
10 mc	-0.14	-0.36	-0.27	- 0.11	+ 0.37	+ 0.78	+ 1.15	+ 1.40	+ 1.70
20 mc	-0.09	-0.00	+0.41	+ 0.76	+ 1.57	+ 2.16	+ 2.63	+ 2.91	+ 3.21
50 mc	-0.01	+0.47	+1.31	+ 1.90	+ 3.15	+ 4.00	+ 4.57	+ 4.90	+ 5.20
100 mc	+0.06	+0.82	+1.99	+ 2.77	+ 4.34	+ 5.38	+ 6.05	+ 6.41	+ 6.71
200 mc	+0.10	+1.17	+2.67	+ 3.63	+ 5.54	+ 6.77	+ 7.52	+ 7.92	+ 8.21
500 mc	+0.17	+1.64	+3.57	+ 4.78	+ 7.12	+ 8.60	+ 9.47	+ 9.91	+10.21
1 c	+0.23	+1.99	+4.25	+ 5.65	+ 8.31	+ 9.99	+10.95	+11.41	+11.71
2 c	+0.28	+2.35	+4.93	+ 6.52	+ 9.51	+11.37	+12.42	+12.92	+13.22
5 c	+0.36	+2.81	+5.82	+ 7.66	+11.09	+13.21	+14.37	+14.91	+15.21
10 c	+0.41	+3.17	+6.50	+ 8.52	+12.28	+14.59	+15.85	+16.42	+16.72
20 c	+0.47	+3.52	+7.18	+ 9.39	+13.48	+15.98	+17.32	+17.93	+18.23
50 c	+0.54	+3.99	+8.08	+10.54	+15.06	+17.81	+19.27	+19.92	+20.22
100 c	+0.60	+4.34	+8.76	+11.40	+16.25	+19.20	+20.75	+21.43	+21.72
Danger Range	Plus	Plus	Plus	Plus	Plus	Plus	Plus	Plus	Plus
20 cm	+0.26	+1.64	+3.16	+ 4.02	+ 5.55	+ 6.44	+ 6.85	+ 7.00	+ 7.00
50 cm	+0.11	+0.71	+1.36	+ 1.73	+ 2.39	+ 2.77	+ 2.95	+ 3.01	+ 3.01
1 m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 m	-0.11	-0.71	-1.36	- 1.73	- 2.39	- 2.77	- 2.95	- 3.01	- 3.01
5 m	-0.26	-1.64	-3.16	- 4.02	- 5.55	- 6.44	- 6.85	- 7.00	- 7.00
10 m	-0.37	-2.35	-4.52	- 5.76	- 7.94	- 9.21	- 9.80	-10.01	-10.01

Table 17. Gamma-ray Shielding (cont.)

	Energy (mev)								
	0.2	0.5	0.8	1.0	1.5	2.0	2.5	3.0	4.0
Working Time, hr/day	Plus	Plus	Plus	Plus	Plus	Plus	Plus	Plus	Plus
1	-0.17	-1.06	-2.04	- 2.60	- 3.59	- 4.16	- 4.42	- 4.52	- 4.52
2	-0.11	-0.71	-1.36	- 1.73	- 2.39	- 2.77	- 2.95	- 3.01	- 3.01
4	-0.06	-0.35	-0.68	- 0.87	- 1.20	- 1.39	- 1.47	- 1.51	- 1.51
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	+0.09	+0.56	+1.08	+ 1.37	+ 1.89	+ 2.20	+ 2.34	+ 2.39	+ 2.39
Absorber	Times	Times	Times	Times	Times	Times	Times	Times	Times
Pb	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fe	8.80	2.88	1.96	1.74	1.49	1.43	1.47	1.48	1.59
Al	41.67	9.80	6.18	5.33	4.83	5.00	5.28	5.68	6.39
H_2O	106.84	21.54	13.42	11.59	10.36	11.11	11.19	12.11	12.78

Notes:

(1) Source activity is quoted in millicuries or curies, where 1 curie is that amount of radioactive material that disintegrates at the rate of 3.7×10^{10} disintegrations/second. However, the table is computed on the further assumption that each disintegration yields one gamma photon of the selected energy. This will lead to inaccuracies whenever the disintegration is complex. More accurate calculations can be made by obvious methods when the disintegration scheme is known.

(2) The tabulation ignores the increased effective transmission of shields under wide beam irradiation.

(3) This form of shielding table (prepared by C. C. Gamertsfelder) is intended to form a guide to rapid erection of temporary shielding structures in the laboratory. Where permanent installations of maximum economy are planned, more detailed calculations by conventional methods are required.

(4) "Danger range" is the minimum working distance.

Secondly, the handling of the isotope may leave appreciable amounts on working surfaces or surfaces of equipment and may thus be generally spread about. Good design, therefore, must include not only proper shielding for minimizing exposure to direct radiation but proper ventilation, proper methods of handling, containers where necessary, and means for ready decontamination of working surfaces and equipment. Shielding from gamma radiation may follow the design outlined for x-radiation of the same energy. The actual intensity is known from the quantity of isotope available, and the shielding requirements may be obtained by calculation. Table 17, reproduced from NBS Handbook 42 (3), may be used to determine the required thicknesses for shielding from gamma-ray sources in the laboratory.

How to Use Table 17. Select column for energy required (use next higher if exact value is not given). Entry gives thickness in centimeters of lead for different source strengths at 1 m for 8 hr/day to give 50 mr. Add algebraically the correction terms for other working ranges or times, and multiply by factor for shield material.

Example: An iron shield is required for the manipulation of 500 mc of radioactive material emitting 1.8 mev gamma-rays at a minimum working distance of 50 cm, and for 4 hr/day. Shield thickness

$$= (\underset{[a]}{8.60} + \underset{[b]}{2.77} - \underset{[c]}{1.39}) \times \underset{[d]}{1.43}$$

$$= 14.3 \text{ cm of Fe, in which}$$

a = basic entry
b = correction for danger range 50 cm
c = correction for 4 hr/day
d = conversion from Pb to Fe

Another procedure is based on the approximate formula,

$$R = 7CE/d^2$$

where:

R = the dose rate in r/hr
C = the number of curies in the source
E = the gamma energy in mev/disintegration
d = the distance in feet

With the example above, we find

$$R = (7)(0.5)(1.8)\frac{1}{(1.64)^2}$$

$$= 2.34 \text{ r/hr}$$

This would give 2.34 x 4 = 9.4 r/day, which is 9.4/.050 = 190 times the permissible dose. From Figure 5 we would find that 8 half-values would reduce the dose to the permissible level. From Figure 6 we obtain 0.8 inch for the half-value of iron for 1.8 mev, yielding 6.4 inches or about 16 cm for the barrier requirement.

Laboratory operations with isotopes, unless they are of a routine nature, are usually handled by constructing shielding from interlocking lead bricks. This is the most flexible system for providing shielding in experimental work. The quantities of radioisotopes involved are usually such that primary shielding alone is sufficient. Of course, this cannot be assumed, but should be checked with survey instruments just as any operation would be checked. Also, it must not be assumed that bench tops or table tops offer good shielding for radiation directed downward.

Industrial tracer operations with isotopes follow those common in the laboratory. The major differences are that ordinarily larger quantities of isotopes are required and that the personnel with possible exposure to radiation are not technically trained. Therefore, it is more critical that they be given proper instruction and protection. Such operations are so varied that only generalized statements may be made. The installation must be designed around the process to be carried out. Protective measures are in this case added features even though they can be made less expensively if included in the original design. This is usually not possible as it is more likely that equipment previously used for normal operations would be modified for the new process.

The basic criterion is the prevention of overexposure. If the concentration of isotope in the material is known, the possible dose rate from

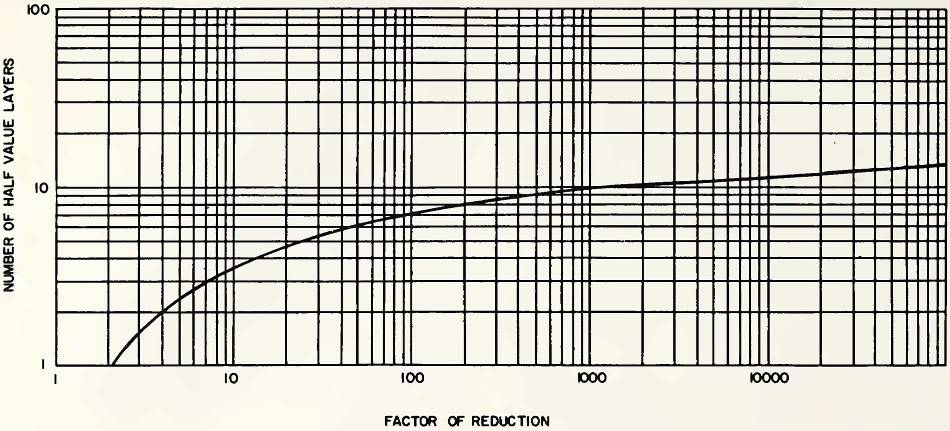

Figure 5. Half Value Layer for Required Reduction

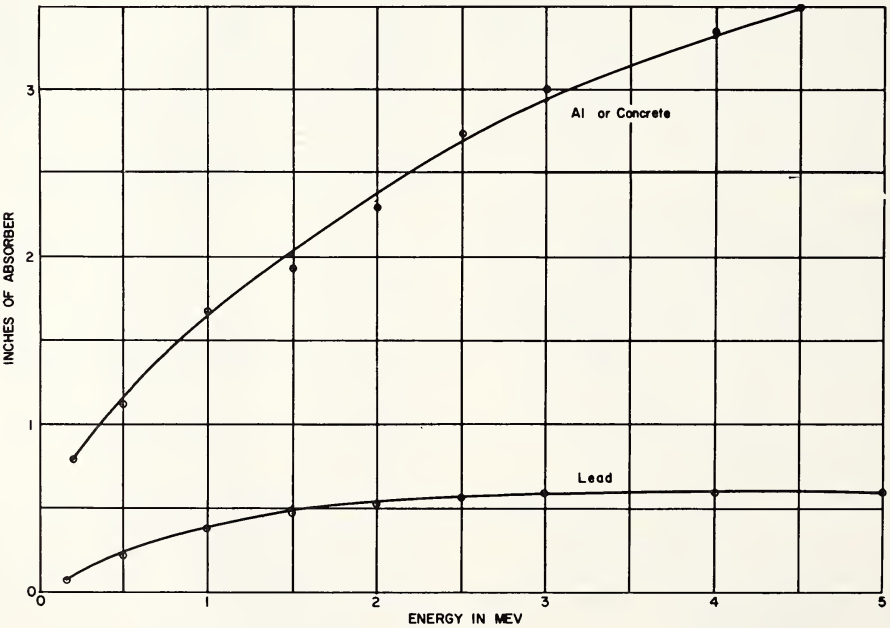

Figure 6. Half Value Layers for Photons and Gamma Rays

the total amount of isotope can be calculated. The safe procedure is to design any required shielding so that if all the isotope were concentrated at any point in the system, the shielding would be sufficient to maintain the dose rate outside the shield below the maximum permissible level. This may not be possible with extremely large quantities of radioisotopes. Where the equipment is extensive it may not be necessary, particularly when dealing with solutions which may be readily homogenized. In such a case the amount of isotope possibly present in any area may be considered as a point source and the shielding for the area calculated on this basis. With beta emitters, the shielding from direct radiation is less of a problem and thick (½ inch or greater), transparent plastic barriers will give sufficient protection. This simplifies any laboratory manipulative operations, because the source is always in sight. Alpha emitters should require no shielding whatsoever. Both of these emitters, however, as well as gamma emitters, do require consideration of the inhalation, ingestion and contamination problems in design. The problem of ventilation for any hazard is described in Section 2 and the criteria for handling various toxic materials apply to radioactive isotopes equally well. The direct ingestion problem can only be handled by habits of personal caution and cleanliness and wearing of suitable protective clothing. It is from the viewpoint of decontaminability that the design of laboratory equipment for radioactive materials differs from other toxic substances.

An isotope laboratory should have special cleaning services. The laboratory personnel should be responsible for cleaning all benches, hoods and cabinets. When floor cleaning is performed, wet mopping or vacuuming through suitable filters is required; sweeping should not be allowed. All pails, mops and cleaning equipment should be assigned to the laboratory and never used elsewhere. In this way they can be monitored frequently and discarded or cleaned if found contaminated.

Radioisotopes usually present a greater hazard than any other toxic material on a pure weight basis. Thus smaller amounts of these substances present real hazards and the design of laboratory equipment to prevent accumulation of these substances is both difficult and costly. Two approaches have been proposed; one is the type of construction involving impervious surfaces, free of seams, using a material that can be readily cleaned. The material most often proposed is stainless steel, which is expensive to buy and to fabricate. The second approach utilizes normal laboratory equipment and covers all surfaces with expendable materials that can be stripped off and discarded. Both methods have their merits and will be discussed in some detail.

One basic fallacy in the initial concept of stainless steel or other "impervious" surfaces is that they are truly impervious. This has been shown to be false. Stainless steel after one vigorous cleaning is found to deteriorate in that more and more material may be absorbed or adsorbed and retained on the surface. Successive cleanings have been found to become more difficult and to require more vigorous methods of decontamination. Glass always shows high adsorptive characteristics for traces of most elements and even the drastic methods of cleaning chemical glassware do not always remove all of the adsorbed material. On the other hand, impervious surfaces can be fabricated to be free of cracks, seams and crevices so that large quantities of an isotope cannot become permanently lodged in the structure.

The removable expendable covering for laboratory surfaces is probably less expensive than the impervious construction. In a typical operation, the bench surfaces may be divided into areas with stainless or plastic trays. These in turn are covered with an absorbent paper with a waterproof backing. In case of spills the paper is discarded as radioactive waste and the trays taken up and cleaned as vigorously as required. Floors are made of rubber or asphalt tile which can be removed and replaced in small areas at a time when or if they become contaminated. Several strippable plastic coatings have been developed for covering vertical surfaces subject to contami-

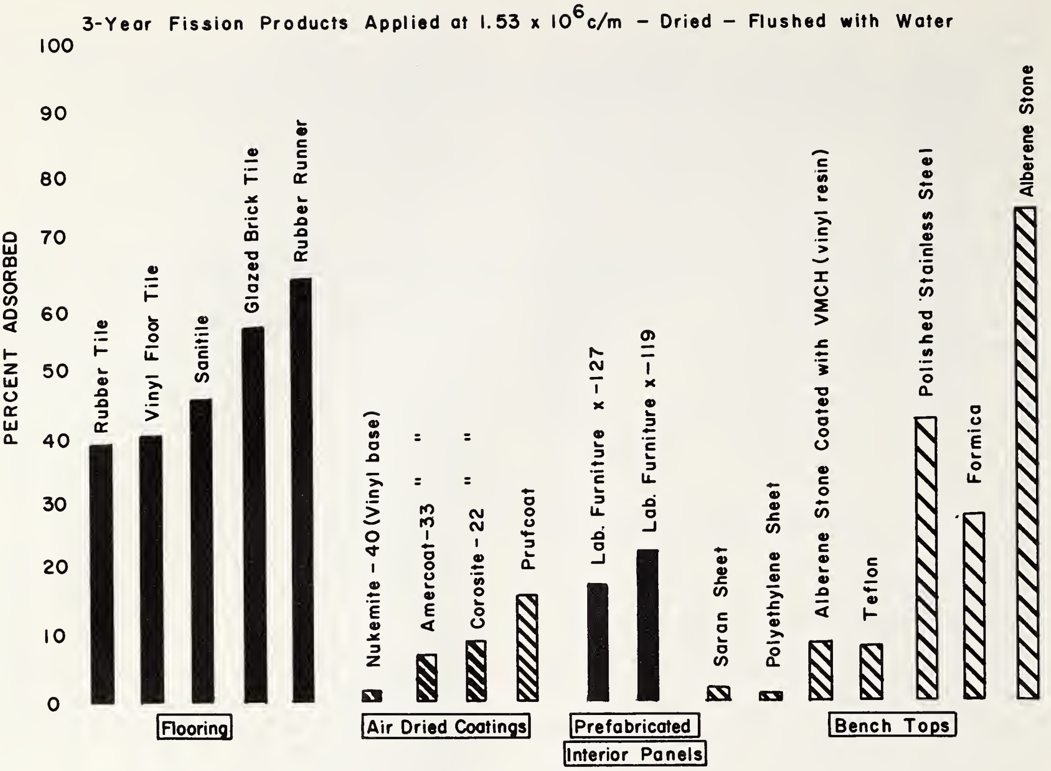

Figure 7. Susceptibility to Fission Product Contamination

nation. These resemble paints in texture and application except they do not form a firm bond on the surface to which they are applied. If they become contaminated, they can be stripped off and replaced.

The replaceable material concept can be carried one step further. Movable work benches of the type used in machine shops can be fitted to chemical procedure by covering with glass, linoleum or "Transite." The coverings can then be discarded if they become excessively contaminated, and even the benches are not expensive to replace. In any case, separation of work tables and cabinets is desirable for preventing the spread of contamination.

The major objections to the use of the replacable type of construction is that large quantities of radioactive wastes are accumulated and that the removal and disposal of contaminated sections may expose the workers to more radiation or radioactive material than a cleaning procedure carried out on an impervious surface. However, such an installation is cheaper, particularly when existing laboratory facilities are being converted to isotope operations, and procedures now exist to allow decontamination to be accomplished safely.

Both methods of construction require constant monitoring to determine when decontamination is required. As in every other phase of radiation protection, there is no need for assumptions that everything is operating properly. Measurements can be made and interpreted and there is no excuse for the statement that any exposure "shouldn't have happened."

Figure 7 shows the properties of various materials of construction with regard to decontamination (15). While data are not available for all isotopes, all conditions and all materials, such a compilation does furnish an indication of materials for design purposes.

The choice of technique, impervious or removable, in setting up a laboratory is governed by cost since either method can be utilized to maintain exposure at levels below the maximum permissible values.

Waste Disposal. The preceding paragraphs have discussed the aspects of three factors—shielding, decontaminability and ventilation—with respect to design. A fourth factor which must be considered in isotope installations is that of waste disposal. This will be covered later but it must be considered also in the design of an installation.

Sinks and drains for carrying off highly radioactive solutions cannot be fed directly into the normal channels. Such installations require two entirely separate waste systems; one for inactive material going directly to the regular sewer system and one for radioactive material which is led into tanks for holdup or processing prior to disposal. In extreme cases these waste lines may also require shielding to prevent overexposure to workers in the area. In any case they should be designed to minimize concentration of isotopes in the lines. Such concentrations can be hazardous when making repairs on high level disposal systems. If the accumulation of radioactive waste includes large quantities of burnable solid materials, the design may have to include a remote storage area and a suitable transportation system to the location where direct methods of volume reduction such as an incinerator and ash disposal system are utilized.

Working Area. The over-all design must be viewed from the standpoint of exposure reduction in isotope and x-ray installations. Adequate shielding and electrical safeguards are the primary considerations for x-rays. In isotope laboratories additional factors of storage space, materials of construction and ventilation are also important. In both cases every effort should be made to use distance as a method of exposure reduction. Radiation sources should not permit exposure to those not working with them directly. In other words, no working areas should be laid out near a high level radiation source. Partitioning may be designed to act not only as shielding but as a physical barrier to prevent passage of workers through or near areas of high radiation exposure. Wherever possible, separate buildings or wings should be adapted for isotope or x-ray operations.

Isotope Storage, Handling and Shipping

Exposures found in shipping, storage and handling of isotopes are separated from those in actual operations because they generally involve an entirely different group of personnel. This group is usually untrained, unaware of the hazards and must operate solely on the basis of directions, without allowance for personal judgment. For this reason the Interstate Commerce Commission and various carriers have set up definite regulations for the shipping of radioisotopes. The storage and handling problems within any installation must be met by similar regulations set up to fit the activity level and exposure time involved.

Since the storage and handling of isotopes includes many of the problems of storing and handling dangerous chemicals, the general safety rules for these must be complied with and will be discussed here in a general way. More details will be given on the specific problems involved in storing and handling radioisotopes.

Storage. Storage facilities are dictated by the type of emitter and the quantity being stored. Laboratory quantities of radioisotopes may not even require a separate storage area but are usually kept away from counting areas to prevent an increased counter background from stray radiation or contamination. Alpha or beta emitters are usually quite well shielded by the actual bottle or other container and additional shielding is best provided by a plastic container having walls that are about a centimeter thick. These containers can be more useful if they are designed to be liquid tight and thus to retain liquids or solutions if the inner container becomes broken. Additional protection is provided by filling with vermiculite or other absorbing material. Loose fitting heavy caps provide sufficient shielding and ease of handling. Laboratory quantities of gamma emitters are best stored in a glass or plastic inner container held within a solid lead block of suitable thickness. Such storage blocks are commercially available or may be readily fabricated. As in the case of the plastic containers, the storage block should have a heavy loose-fitting cap to provide sufficient shielding from the top and to allow ready removal. Radioisotope solutions, whether in tracer quantities or large amounts, should preferably be contained in an unbreakable plastic bottle. Polyethylene bottles resist the action of most chemicals and can stand accidental dropping without breaking. With the larger amounts of radioactivity, a secondary waterproof container packed with absorbent material should always surround the primary bottle before it is placed in the storage shield. This will prevent contamination of the shield if leakage of the primary container occurs.

In many cases the lead bricks described for temporary shielding may serve to protect a gamma emitter for the period of storage. Such shields, prepared from lead bricks, should only be considered for temporary operations as they do not give complete protection from all directions unless an elaborate structure is erected.

Whenever larger than laboratory quantities of isotopes must be stored, it is advantageous to set up a separate storage area. This will minimize the shielding requirements, if the area is isolated from work areas and normal traffic. Frequently a basement is most adaptable, as no shielding need be provided for the floor and most of the wall area. With alpha or beta emitters, mere isolation of the source from the work areas or traffic is sufficient and no shielding would be required. With high level gamma emitters it is desirable to lower the source into steel tanks or cylinders imbedded in concrete beneath the cellar or basement floor. The cylinder or tank acts as a container and does provide some shielding from radiation coming through the walls at an angle which would allow it to reach a populated area. The most important shielding is on the top which is the direct radiation field. A lead or steel cap for the tank or cylinder can be fitted with a ring bolt and raised or lowered by means of a chain hoist. Ventilation is required, particularly if radium or thorium sources are kept in the storage room.

Any open storage installation must meet the requirements that no exposure above the permissible level is possible. This should be true if a person were to spend his full working time within the storage area with all sources in their storage containers and capped. While this requirement may seem excessive, since personnel ordinarily do not operate within the storage area, it is necessary because the workers involved are usually untrained. For the very few installations using multicurie quantities of isotopes, a time and distance requirement may be set up and higher dose rates allowed. The storage area in such an installation should be locked and should only be opened by a responsible supervisor. When entering such an area the handling crew should be under the control of the responsible supervisor who should remain outside the doorway to the storage area. The doors, although locked from the outside, should be capable of being readily opened from the inside to prevent anyone from locking himself into the room. The general instruction for layout of a completely protected radiation source, given in pp. 104-115 should apply to the storage area for multicurie lots of isotopes.

Handling. As in all operations, the handling of radioisotopes must be set up to prevent excessive exposure to personnel and in fact to prevent any unnecessary exposure. The operational techniques, whether for the plant or laboratory, must be carefully planned to prevent direct radiation exposure and inhalation or ingestion of radioactive materials. After planning any operation, it is advisable to make one or more test runs of the complete procedure using inactive materials. It will be found that this will reduce exposure markedly by familiarizing personnel with the techniques so that they may be performed more rapidly. In addition, it is frequently found that such tests will show how process improvements may be made. The advantage is even more marked where unfamiliar apparatus is required or where there is a necessity for working around or over shields where normal body movement is not possible.

During usual handling operations on either a laboratory or plant scale, the greatest exposure is likely during transfer of the radioisotopes. Transfer is involved in preparation of solutions, weighing or measuring quantities into new containers or loading reaction facilities. Regardless of the type of emitter or its physical state, the operations are best carried out in a well ventilated hood or glove box. This is most important with finely divided solids or other materials which may become air-borne. The hood interior should be readily decontaminated to remove the normal spillage which occurs during transfer operations. This is discussed in the section on Decontamination (pp. 101-104).

The shielding of actual operations depends entirely on the type of emission shown by the isotope. Alpha emitters require no shielding, beta emitters are best shielded with transparent plastic, while strong gamma sources may require lead or steel. If the operation requires heavy shielding, remote control of the apparatus must also generally be provided. This would not necessarily be a complete mechanical robot system but might merely be an extension of all controls outside the shield. Remote control equipment, such as tongs or solution transfer devices are commercially available which allow handling at a distance. The usual beta emitter operations would take place behind a plastic shield with cutouts for arms so that the operator can reach inside to carry on the process. Where high activity is present or if possible hand contamination is a problem, the operator may wear long gauntlet gloves where the cuffs are sealed to the shield. Such complete units, called either glove boxes or dry boxes, are available commercially and are very convenient for carrying out small scale laboratory or pilot plant operations.

Shipping. Radioisotope shipments are controlled by regulations of the producing installation, usually AEC Isotopes Division, Oak Ridge, and of the carrier, the Interstate Commerce Commission or the Civil Aeronautics Board. These regulations are designed both to prevent any excessive exposure to shipping personnel and to prevent damage to materials such as photographic film which are sensitive to radiation.

Since the limiting factor of most regulations is the dose rate at the surface of the package it has become customary to increase the size of the outer packing container rather than to increase the weight of shielding. This is usually more effective if packing and shipping costs are considered. In other words, a 1 inch cube source might have to be contained in a 4 inch cube of lead for adequate shielding. The same reduction in surface dose rate (for high energy gamma) could be obtained by placing the original source in a corrugated carton 1 foot each dimension. The latter method would be much less expensive. However, the shipping carton must be strong enough to survive handling and the source must be fixed in the center of the carton so that it cannot shift to one of the carton faces.

The shipping regulations applying to the transportation of radioactive materials are included in Section 11.

Radioisotope Waste

All operations involving radioisotopes produce radioactive material which is no longer suitable for use. Such material must be disposed of and such disposal is a major responsibility of those in charge of the operations. The actual methods of disposal depend on the activity level, the type of waste, and the radiochemical properties of the isotopes. The two major methods of disposal are dilution and containment, and these will be discussed in relation to the considerations mentioned and the quantity and type of inert waste material associated with the radioisotope.

Dilution is the process of mixing the waste with sufficient inert material to reduce the concentration of activity below the permissible levels. An example would be the flushing of microcurie amounts of an isotope into the regular sewer system. Containment is the storage of waste under conditions that keep it from being spread and that keep it isolated to prevent direct radiation exposure. As the total quantity of isotopes being handled in the world increases, more and more emphasis is going to be placed on containment, and this method should always be given primary consideration. The adoption of a conservative attitude in waste disposal has several advantages. First, little is actually known about the process of concentration whereby plant and animal life may collect appreciable amounts of an isotope. Second, poor public relations may result from the exposure of large off-site populations to any measurable radioactivity. Third, local public health officials may yield to public appeal and set further restrictions on disposal if levels near the maximum permissible are found.

Activity Level. For the purposes of this discussion, a low activity level will be defined as one where the concentration can be reduced below the maximum permissible level by reasonable dilution. Other considerations may dictate the use of a containment procedure, but this definition will assist in waste disposal planning. High activity levels are those that cannot be treated by moderate dilution. Where large quantities of such wastes must be handled, it becomes necessary to reduce the bulk of material by concentration. Even though this process raises the relative activity of the waste to a much higher level, the storage becomes much less of a space problem.

Type of Waste. The three forms of waste material produced in isotope operations are solid, liquid, and airborne. In most contaminated solid materials, the activity per pound of waste is relatively low. Such material presents a considerable storage problem and efforts are usually made to reduce its bulk by incineration or baling. Liquid wastes are also bulky and must be concentrated by evaporation or the activity must be removed by some process such as precipitation, flocculation, or ion exchange. Air-borne wastes may involve either radioactive gases as in pile effluents, or air-borne dusts such as hood exhausts. The containment and storage of waste gases is impossible and reduction in contamination must be made by collecting the radioactive material by absorption, scrubbing or removal of particulates by filtration.

In all three cases, a preliminary step of waste concentration is possible. For high activity levels this may be the only disposal operation with the exception of storage. Solid wastes are treated the same for all activity levels but liquid or gaseous wastes involving low activity levels can frequently be disposed of by simple dilution. In particular, the dilution of contaminating gases may be made great enough so that the activity of the surrounding air is not appreciably increased.

Equipment which has become contaminated cannot be disposed of simply by dumping, as it may appear in a critical location later as second hand equipment. Frequently the cheapest method of disposal is to decontaminate the article sufficiently so that it can be returned to the normal channels of commerce. This is being done successfully with scrap steel contaminated with uranium at plants processing materials for the AEC. Further work will probably extend such methods to other materials and other contaminants.

Radiochemical Properties. The important properties of waste for disposal are the type and energy of the radiation, and the half-life and relative biological hazard of the isotope. Alpha emitters are a considerable hazard when taken internally but are relatively harmless as long as they as they are outside the body. Beta emitters have an intermediate hazard rating both internally and externally, while the gamma emitters are chiefly an external hazard.

The probable fate of the waste will regulate the relative amounts of these materials that can be disposed of safely through normal channels. Alpha emitters are all heavy metals and tend to be deposited in the bone. Thus they must be kept out of food or drinking water and must be prevented from becoming air-borne. However, they may be stored in large quantities without hazard, so they are not ordinarily released into the normal disposal channels. Long-lived beta and gamma emitters such as Sr^{90} are subject to the same considerations. In addition, their storage may require shielding to prevent exposure to possible external radiation hazard.

The energy of the radiation, along with the type, will determine the amount of shielding that must be included in any containment method. The range of all alpha emitters is such that relatively light containers or shielding may be used. Energetic gamma emitters would require heavy shielding or a large no-man's land around a storage area.

Half-life is an important consideration, as short-lived emitters may be economically stored until their activity has decayed to a negligible value. Also, the biological hazard from the short-lived materials is considerably less than for long-lived emitters. As the half-life becomes longer the cost of storing large quantities for the required period of years becomes appreciable. Safe methods are therefore sought for low cost disposal of these materials by burial or dumping them at sea. Sea disposal is covered in NBS Handbook 58 (16).

The maximum permissible concentrations of several radioisotopes in water and air were given in Table 4. These values take into account the considerations mentioned in this section and are the criteria for waste disposal. Wastes with activities that can be diluted to these levels may be disposed of through normal channels. However, it should be emphasized again that disposal levels should be maintained as low as possible. This will give leeway both for accidental discharge of larger quantities of wastes and for any tightening of disposal restrictions in the future.

Methods of Disposal. Dilution may be applied to low levels of beta and gamma emitters and even to short-lived alpha emitters, such as radon gas. The isotopes P^{32} and I^{131} have been so widely applied in medical work that specific recommendations for their disposal have been issued in NBS Handbook 49 (17). The instructions are very detailed, but it might be noted here that it is permissible to discharge 10 mc of these isotopes in a single disposal for each million gallons of daily sewage flow. Larger quantities must be fed into the system at intervals to insure sufficient dilution, or stored to allow for decay.

Other dilution processes are similar enough to require no further coverage, but some description of a few of the methods that have been applied to containment will be given. The initial step is usually one of concentration, either on a weight or a bulk basis. For example, contaminated clothing could be incinerated to give both a weight and bulk concentration, or it could be baled to give a bulk concentration. Either of these will assist in reducing the required storage area.

Segregation of high and low level wastes has been found to be a valuable step at the Knolls Atomic Power Laboratory of the General Electric Company. They have described (18) how slightly contaminated wastes may be baled with a lower installation and operating cost than incineration. The gain in volume reduction is only 4 to 1 for incineration over baling for combustible materials, and is even less for mixed solid wastes.

The incineration process suffers from the requirement that considerable care must be taken to remove radioactivity from the flue gases of the incinerator. Entrainment of solid material by the hot gases can carry appreciable amounts of material out the stack making some form of stack gas cleaning necessary. The general problem of incinerator design has been described in a report (19) on a pilot incinerator at the Knolls Atomic Power Laboratory. The major differences from the normal incinerator are the cleaning of the flue gas and the requirements for handling the ash without extensive exposure to personnel. For small installations, standard commercial waste incinerators are satisfactory.

The two procedures for reducing the bulk of solid waste that have been given are the only ones in current use. Many installations with small quantities of waste of course find it possible to handle their material without bulk reduction.

Liquid wastes are ordinarily solutions or suspensions of radioactive materials in a large bulk of solvent. A simple method of bulk reduction is by evaporation, but the amounts of heat required for dilute solutions may make this an expensive operation in spite of its simplicity. As in the case of incineration, the exit gases or vapors from the evaporator must be cleaned before discharge to the atmosphere. The amount of liquid entrained in vapor coming off a boiling solution can represent several per cent of the total liquid volume. This can only be removed at considerable cost as any filters in the system must be heated to prevent excessive condensation.

An isotope in solution or suspension can frequently be concentrated by precipitation of specific materials or by general collection with a flocculating agent. The alum process used for water purification will scavenge many different isotopes and yield a resulting liquid which may be suitable for disposal through the normal sewer system. Other methods such as the precipitation of calcium phosphate have given effective scavenging from aqueous solutions. Any precipitation or flocculation process requires filtration to remove the concentrated activity and the carrying material. Sedimentation processes are not sufficiently efficient and a large volume of liquid waste requires a sand bed filter or other large unit to handle any appreciable volume. Small volumes may be treated with standard laboratory equipment and setting aside a small area for such processes will reduce possible contamination of other laboratory areas.

Considerable research is now being done on the removal of isotopes from liquids by ion exchange. Both the ion exchange resins and the montmorillonite clays are being tested as scavenging agents. These have the advantage for small installations that they can be run efficiently on an intermittent basis. When their capacity has been reached, as indicated by activity passing through the system, the resin or clay can be treated as a compact solid waste for disposal. The clays have the advantage that high temperature baking gives a massive product which can be buried at sea without packaging.

Any intermittent handling process for liquid wastes requires that adequate storage tank capacity be available to contain the waste accumulated in the period between disposals. Naturally, with short-lived isotopes a system of hold-back tanks may be the only requirement for waste disposal. The liquids are stored until a test shows that the activity level is below the limit permissible for disposal into the normal sewer system. Long-lived isotopes may merely be held until processing facilities are ready to accept the waste.

Air-borne wastes may be concentrated by filtration of particulate matter or by absorption or scrubbing of radioactive gases. These processes yield solid or liquid material as a concentrate and the wastes are disposed of as described above.

The dilution of radioactive gases may be made very effective by means of a tall stack. This is required only for reactor effluents, but consideration might be given to use of an existing stack even for low level radioactive gases.

For the small isotope user, there are waste disposal services in several large cities which have been authorized to collect, store and dispose of isotopes. If preferred, wastes may be packaged and shipped to the Oak Ridge National Laboratories after arrangements have been made.

Medical Programs and Records

As radioisotope and x-ray utilization in industry increases it becomes much more important that adequate knowledge of the exposure of everyone employed in these fields is maintained. The employer must protect himself and his employees with a complete medical protection program and must maintain complete medical records and radiation exposure records on each employee. These will be invaluable if any question of radiation damage occurs and in addition will furnish future information for the scientific evaluation of long-term exposure to low radiation levels.

The medical program in itself can only be an added precaution for radiation control and will be most valuable in maintaining the general health of workers. The clinical symptoms of radiation damage occur only with a considerable overexposure. Therefore, the responsibility for prevention of radiation damage rests entirely on the personnel monitoring and control systems.

This section can only outline briefly the desirable features of a medical protection program and will emphasize the exposure and medical records.

At the present time there are only a limited number of medical tests available for radiation protection. Most exposure information is still obtained from personnel and area monitoring. Any radiation protection program is a failure if clinical evidence of radiation damage appears. Such a statement is not always true for other toxic materials, as clinical evidence sometimes may appear and a course of treatment may be indicated which may restore the worker to complete health. In case of radiation, the first clinical signs appear after considerable non-reversible damage has occurred. Thus, medical tests are not as much a part of a protection program as they are a confirmation that some acute overexposure has occurred.

A complete blood count is often recommended as a check on radiation exposure, but is not in favor with medical men interested in radiation protection. The most marked change is ordinarily seen in the leucocyte count and more specifically in the lymphocytes. A significant decrease is considered to be an indication of overexposure. The normal variation in various cell counts obscures the small variation caused by low level exposure. When a positive indication is given by blood count it means that the subject has received definite overexposure approaching the acute stage. A systematic following of each individual could possibly give trends indicating chronic low level exposure, but such data have not been available on industrial or laboratory populations in the past.

One of the most valuable functions of a medical staff in a radiation protection program is in the selection of employees. Those candidates showing symptoms of normal disease which may also be attributable later to radiation should not go into a job requiring radiation exposure. This will obviously protect the employer and, less obviously, the candidate as radiation may aggravate an existing condition. A typical example would be those showing signs of anemia.

If the medical examiner has some idea of the operations, he may be more useful in selecting candidates. Certain positions require certain mental characteristics as well as physical features, particularly where failure of the individual may endanger others. This has been a familiar industrial problem for many years and is not peculiar to jobs with a possible radiation exposure.

The medical examiner should be familiar with the clinical symptoms of radiation damage and be particularly observant for such symptoms. If examination of his exposure record shows that it is complete and that no overexposure has occurred, the examiner may return the employee to exposure conditions.

In particular, the medical examiner should be familiar with the details of metabolism and the permissible levels of any isotopes handled in the plant or laboratory under his control. This is not required for the treatment of overexposure but rather for the recognition of the hazards which may exist.

Complete semi-annual or annual medical examinations of all exposed employees should be required. This should include a full chest x-ray and blood count as well as the normal examination. In particular, the condition of the skin, nails, and eyes should be noted in the examination. It should be remembered that while the blood count is not a reliable indication of chronic overexposure, it is valuable as an aid in diagnosing acute overexposure. Additional examinations should be performed whenever the employee exposure record indicates an acute overexposure of 25 r or greater.

The examination for selection of employees should be as complete as the periodic examination. In addition, it is desirable to obtain the entire radiation history of the candidate, particularly if he has incurred industrial radiation exposure. An exposure history should not be grounds for turning down the candidate but a knowledge of previous exposure is desirable and should be included in the employee's record.

A complete set of records should be maintained for each employee. This should include the results of each medical examination, history of illnesses, exposure data and the results of any special tests such as urinary excretion of isotopes or breath radon measurements. Such records should be maintained in an individual file for each employee and should be reviewed at each periodic physical examination. While any overexposure must be brought to the attention of the qualified technical person in charge of the protection program, it is worthwhile for him to also review the cumulative records at least semi-annually. This will show which employees and which operations are showing the greatest exposure. Such knowledge may enable him to correct minor difficulties and reduce exposure appreciably. This again is part of the concept that maintenance of exposure below the permissible levels is not a sign of a perfect protection program and that efforts should be directed toward reducing all exposure to the minimum.

The exact form of the records is subject to individual preference. No standard form has been adopted by any group since the exposure conditions and type of exposure vary from operation to operation. The chief requirements are that the form when properly filled out gives a complete record of the results of medical examinations and personnel monitoring data.

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SECTION 6

INDUSTRIAL FIRE PROTECTION

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What Is Fire?

Fire, combustion, or burning requires three things: (1) a *fuel* (any oxidizable material); (2) *oxygen* (usually air); and (3) a certain *temperature* (heat). Fire is the chemical union of oxygen with fuel, accompanied by evolution of thermal energy, indicated by incandescence or flame. If any one of these three constituents is not present in the proper proportions or degree, no fire will occur. If a fire exists and even one of them is sufficiently altered, the fire will go out. Therefore, in its simplest form, all fire control or extinguishment reduces to a manipulation of these three essential constituents.

Classification of Fires

Class A Fires are fires in *ordinary combustible materials* where the quenching and cooling effects of quantities of water or solutions containing large percentages of water are of first importance. Ordinary combustible materials tend to produce glowing embers after burning, and these must be quenched to prevent rekindling.

Class B Fires are fires in *flammable liquids* (oils, gasoline, solvents, etc.), where a blanketing or smothering effect is essential to put the fire out. This effect keeps oxygen away from the fuel, and can be obtained with carbon dioxide, dry chemical (essentially sodium bicarbonate), foam or with a vaporizing-liquid type of extinguishing agent. Water is most effective when used as a fine spray or mist.

Class C Fires are fires in *electrical equipment,* where the use of a nonconducting extinguishing agent is essential. Water spray, carbon dioxide, dry chemical or vaporizing liquid is satisfactory.

Metal and gas fires have not yet been classified. These require special agents and techniques. For a discussion of extinguishing agents and techniques for these classes of fire, see pages 143-144.

Definition of Terms

The meanings of fire control terms as used in this book are as follows:

Flash point (Flash P.) is the lowest temperature at which a liquid will give off flammable vapor at or near its surface. This vapor forms an intimate mixture with air, and it is this mixture which ignites. The flash point of liquids is usually determined by the Standard Method of Test for Flash Point with the Tag Closed Cup Tester (ASTM D56-52, available from the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.). This method is also the standard of the American Standards Association (ASA Z11.24-1952, available from the American Standards Association, 70 East 45th St., New York 17, N. Y.). The Interstate Commerce Commission uses the Tag Open Cup Tester giving results 5-10 °F higher (less flammable). Other methods frequently used are Cleveland Open Cup and Pensky-Martens. The closed cup flash point value is usually several degrees lower (more flammable) than the open cup, as the test in the former case is made on a saturated vapor-air mixture, whereas in the latter case the vapor has free access to air and thus is slightly less concentrated. For this reason, open cup values more nearly simulate actual conditions. (See pp. 133-134.)

Fire point (Fire P.) is the lowest temperature at which a mixture of air and vapor continue to burn in an open container when ignited. It is usually above the flash point. Where the flash point is available, only it is given; if it is not, the fire point may be given. It is at least as significant as the flash point as an indication of the fire hazard of a material.

Autoignition temperature (Autoign. Temp.) is the temperature at which a material (solid, liquid, or gas) will self-ignite and sustain combustion in the absence of a spark or flame (ASTM Designation D286-36). This value is influenced by the size, shape and material of the heated surface, the rate of heating (in the case of a solid) and other factors.

Vapor density (Vap. D.). This value expresses the ratio of the density of a vapor to the density of air. The vapors of most flammable liquids are heavier than air; thus they can readily flow into low areas, excavations and similar localities. Hence, ventilating outlets in a plant should be located near ground level. For combustible gases and vapors which are lighter than air, ventilating outlets should be near the ceiling.

Melting point (M. P.). This is the temperature at which the solid and liquid forms of a substance exist in equilibrium. This value indicates at what temperature flammable materials that are solid at room temperature may become flammable liquids.

Boiling point (B. P.). This is the temperature at which a continuous flow of vapor bubbles occurs in a liquid being heated in an open container. The boiling point may be taken as an indication of the volatility of a material. Thus, in the case of a flammable liquid, boiling point can be a direct measure of the hazard involved in its use.

Formula. In the event of a lack of information regarding a material, its formula can give a clue to its fire hazard. For instance, all materials composed solely of carbon and hydrogen are combustible and in some degree flammable. If they are liquids with a low boiling point they can be assumed to be fire hazards.

Underwriters' Laboratories Classification (U.L.C.) is a standard classification for grading the relative fire hazard of flammable liquids against the following standards:

Ether class	100
Gasoline class	90 - 100
Ethyl alcohol class	60 - 70
Kerosene class	30 - 40
Paraffin oil class	10 - 20

Where this value is known it is an excellent measure of the relative hazard of a flammable liquid. Unfortunately, it is available in only a few instances.

Susceptibility to spontaneous heating (S.S.H.). Many materials combine with atmospheric oxygen at ordinary temperatures and liberate heat. If the heat is evolved faster than it is dissipated due to poor housekeeping, a fire can start, particularly in the presence of easily ignited waste, etc. ("Factory Mutual Modified Mackey Method," Industrial and Engineering Chemistry, March, 1927).

Explosive range or Flammability limits. These values expressed in per cent by volume of fuel vapor in air are the ranges of concentration over which a particular vapor or gas mixture with air will burn when ignited. If a mixture within its explosive range of concentrations is ignited, flame propagation will occur. This range will be indicated by L.E.L. for lower explosive limit or U.E.L. for upper explosive limit. The values given, unless otherwise indicated, are for normal conditions of temperature and pressure.

FIRE PROTECTION

The two main aspects of fire protection are prevention and loss limitation.

Prevention. Fire prevention is an inseparable requirement of fire safety; and since in order for a fire to start all three necessary constituents must be represented, effective fire prevention simply boils down to manipulation of these constituents to the extent that a fire cannot start. For instance, where a flammable material such as acetone is used out in an open work shop, two of the three needed constituents are immediately present, i.e. the fuel and a supply of oxygen. Now the only thing lacking to start a fire is heat. Thus by referring to Acetone in Section 10 it is found that the flash point is 14°F, which means that at any temperature above 14°F, acetone can evolve enough vapor to form a flammable mixture with air which will catch fire if exposed to a spark, flame or other source of ignition. Thus, strictly from the standpoint of fire prevention in an installation using acetone, the following avenues are open:

(1) the working (ambient) temperature must be kept below 14°F;
or (2) the supply of atmospheric oxygen must be cut off;
or (3) sources of ignition, such as flames, glowing cigars and cigarettes, sparks, etc. must be eliminated from the area;
or (4) the area must be ventilated so that even though the acetone was giving off enough vapor to form a flammable mixture with air, the vapor would be drawn out of the area by means of fume exhaust equipment as rapidly as it was evolved, thus preventing the build-up of dangerous concentrations of vapors.

Naturally, since conditions (1) and (2) above are relatively difficult to attain on an industrial scale, conditions (3) and (4) are the ones most likely to be used.

Furthermore, although total removal of any one of the necessary conditions for a fire will absolutely prevent its occurrence, such stringent restrictions on industrial operations are seldom economically feasible. Industrial materials are, however, studied with a view to ascertaining just how much leeway there is, so that a compromise between absolute fire prevention and economy of operation may be reached. It is for this reason that, while we know how to prevent fires, they still do start, and why loss limitation is such an important part of industrial fire protection.

Below is some discussion of the three essentials of fire.

Oxygen. Although under certain unusual circumstances it is possible to produce combustion-like chemical reactions with materials such as chlorine or sulfur, it is safe to say that nearly all combustion requires the presence of oxygen. Also the higher the concentration of oxygen in an atmosphere the more rapidly will burning proceed. Industrially it is difficult to manipulate the oxygen concentration in a working area, particularly since a concentration of oxygen far enough below normal to keep fires from starting would also be too low to support human life.

When industry has found it necessary to work with materials so sensitive to oxygen that they would catch fire at ordinary temperatures merely upon being exposed to air, it has found it possible to isolate such materials from air, either in a vacuum chamber or in a chamber filled with an inert atmosphere, such as argon, helium, or nitrogen. In Section 10 the materials which require such isolation are so noted.

Heat as a necessary component of fire is one that is often manipulated to render an industrial set-up safe from fire. The most difficult aspect of controlling the heat component of a fire is the easily overlooked fact that to *start* a fire it is often necessary to heat to a sufficient degree only a *very small quantity of fuel and oxygen mixture.* Then, since fires are by definition exothermic, the very small fire started by a tiny heat source supplies to its surroundings more heat than it absorbs, thus enabling it to ignite more fuel and oxygen mixture, and so on, until very quickly there is more heat available than is needed to propagate a large fire. The heat may be provided by various sources of ignition, such as high environmental (ambient) temperatures, hot surfaces, mechanical friction, sparks or open flame.

Sources of Ignition

The following are the chief sources of ignition and suggestions for reducing the hazard due to them:

1. **Open Flames.** At or near a flammable-liquid installation it is necessary to check for such sources as burners, matches, lamps, welding torches, lighting torches, lanterns, small furnaces and the possibility of

broken gas or oil lines becoming flaming torches. Ample isolation may often be obtained by means of partitions. In this respect the partition should be substantial enough to contain the fire while the sprinklers or other fire-fighting apparatus put it out. Fire-resistant construction, i.e., brick or concrete walls, is generally recommended.

It is important to confine the flammable liquid while it is in use. Safety cans should be used for transporting small quantities of flammable liquids about a working area, as well as for storage at a bench. Wherever possible, closed systems should be used to prevent the spread of fumes, etc. In the event of a fire, it is imperative to prevent spreading of the fire. Hence all tanks should have trapped overflow drains leading to a safe place. Dikes must be used to contain the overflow of burning liquid; otherwise fires could easily spread over large areas, trapping personnel and causing great damage. The principle behind this form of protection is to contain the fire at all costs. Installations of flammable liquids in upper stories should be made only in such a fashion that burning liquid will be prevented from flowing down stairwells, pipe openings, cracks in walls, etc., by means of waterproof floors, dikes, overflow pipes, etc.

2. **Electrical Sources** (Electric power supply and generating equipment, heating equipment, and lighting equipment). The following precautions for good maintenance are suggested. A complete listing cannot be given here. The provisions of the National Electrical Code are the recognized standard and these should be carefully observed in installing electrical equipment in hazardous locations.

(a) Use special wiring and conduit.

(b) Use explosion-proof motors, particularly if located at ground level or in pits or low places.

(c) Use only specially engineered heating units, keeping in mind the autoignition temperature of the material in use (hot water or steam heating units are much to be preferred).

(d) Controls for motors, thermal cut-outs, switches, relays, transformer contactors, etc., which are liable to spark or heat up should not be installed in flammable liquid storage areas. Use only explosion-proof push-button control switches within such an area.

(e) In dangerous atmospheres and for storage, only vapor-tight globes with electric lamps may be used. In well-ventilated areas ordinary lamps will do. Fixed lamp installations are to be preferred to extension cords. Also, approved safety flashlights are preferred to portable lamps.

(f) Do not install fuses or circuit breakers in hazardous locations except in explosion-proof cases.

(g) Motor frames, control boxes, conduits, etc., should all be grounded in accordance with the general requirements for installation of electric power as outlined in the National Electrical Code.

3. **Overheating** (Excessive temperatures at points requiring heat). Such processes should be kept out of combustible buildings and closely supervised. The use of automatic temperature controls and high-temperature limit switches are recommended, although supervision is still important.

4. **Hot Surfaces.** The incomplete immersion of hot metal in quenching baths, the contact of flammable vapors and hot combustion chambers, hot dryers, ovens, boilers, ducts and steam lines all are frequent causes of flammable vapor fires. Care should be taken that material whose autoignition point is lower than the temperature sometimes reached by operating equipment be kept at a safe distance from such equipment. This equipment should be carefully supervised and maintained to prevent accidental overheating, etc.

5. **Spontaneous Ignition.** Many fires are caused by spontaneous heating of materials, accelerated by external heat from processes such as dryers, ovens, ducts, impregnating or steam lines adjacent to piles of waste materials. Sometimes the accumulated heat in a closed, unventilated warehouse will be sufficient to accelerate oxidation to the point of an actual fire. Wherever flammable liquids are handled, particularly those which are known to be liable to spontaneous heating, it is important to pay

particular attention to housekeeping and ventilation. Fires are almost sure to follow neglect of these matters. All equipment and buildings should be kept free of deposits and accumulations of wiping rags, waste materials, oil mops, etc.

6. **Sparks, etc.** Sparks from mechanical tools and equipment, hot ashes from smoking, unprotected extension lights, boilers and furnaces, backfire from gasoline engines, are all potential causes of fire. Smoking should be prohibited in areas where flammable liquids are stored or are used in the open. All equipment in such areas should be maintained in first class condition. Wherever possible, spark-proof or non-sparking tools and materials should be used.

7. **Static Electricity.** This is due to electrical impulses generated on the surface of a material by friction, such as calendering, printing, and the like. Many fires are caused in the rubber and paper industries by this means. Most of these occur during the months when humidity is relatively low, and artificial heat is used. Maintaining a relative humidity of from 40 to 50 per cent in rooms where flammable liquids are used will greatly reduce the chance of static sparks. Electrical grounding, static discharge devices, etc., should be mandatory, and all flammable liquid tanks, piping and equipment should be so interconnected and grounded that the chances for static sparks are minimized. In all this type of equipment, belts should be eliminated and direct or chain drives used wherever possible. If belt drives must be used, the belt speed should be kept below 150 feet per minute, or a special belt dressing should be used which will reduce the possibility of the formation of a static spark.

8. **Friction.** Many fires are caused by mechanical friction, i.e., from fan impellers rubbing on casings, poorly lubricated fan bearings, grinding processes and machining, etc. Fans and other equipment should be frequently inspected and maintained in the best possible condition. Other processes known to generate a good deal of heat due to friction should be well separated from locations where flammable liquids are stored or used.

It is vitally necessary that a complete program for the handling, transfer and use of flammable liquids be set up and maintained. This program should start when the process is initially under construction. Where flammable liquids are called for in the original write-up of a process, the first question is to determine whether the flammable material can be replaced by a nonflammable one. If the question of cost arises it should be remembered that, to the possibly low cost of the flammable liquid, should be added the cost of special protection needed to use it safely as well as its effect upon the insurance rate. It may well be that in the final analysis, the cost of a flammable material is not as favorable as it seemed at first. However, there are many flammable materials in constant use for which there are no substitutes; but even they can be safely handled if proper precautions are taken.

Fuel. The third aspect of fire prevention is the fuel itself, that is, the substance that is burning. Combustion takes place most readily between oxygen and a fuel in its vapor or other finely divided state. Solids are most easily ignited when reduced to powders or vaporized by the application of heat; but except in a few cases the temperatures required for the vaporization of solids are well above normal ambient temperatures.

Liquids present a different case. Some liquids will give off dangerous quantities of flammable vapors well below normal room temperature (the vapor pressure of a liquid is a measure of this effect); others do so at points only slightly above room temperature, and still others at much higher temperatures. It is apparent that the temperature at which a liquid evolves vapors which can form flammable mixtures with air is a measure of its hazard potential. This is indicated by the flash point.

So indicative of fire hazard is the flash point of a liquid that the Interstate Commerce Commission rates any liquid whose flash point is 80°F or below as a high fire hazard, the theory being that 80°F represents the upper limit of normal or "room" temperatures; any liquid which will flash at or below this point is dangerous. A flash point of from 80°F to 350°F indicates a moderate fire hazard; above 350°F the fire hazard is considered slight. The National Fire Protection Association rates as a high hazard a liquid whose flash point is less than 20°F; moderate from 20° to 70°F, and slight from 70° to 200°F. Only liquids having a flash point less than 200°F are generally called flammable by the National Fire Protection Association.

In this book we use the I.C.C. classification for liquids of flash point at 80°F or less as being dangerous fire hazards; we use the range from about 80° to about 225°F to indicate moderate fire hazard; and flash points in excess of about 225°F are rated as slightly hazardous. It should be understood, however, that practically all organic materials will burn if exposed to sufficiently high temperatures. The ratings given above are merely an indication of the risk involved in handling or storing them.

It is important to isolate a potential fire hazard. Thus it is necessary to use closed and vented tanks to hold flammable liquids. In this way the possibilities of igniting the tank of liquid are greatly reduced, as is the chance of materials at a distance from such a tank becoming involved in fires. It is also important that flammable materials be housed in fire-resistant structures because burning liquids can generate great heat and often set fire to the buildings in which they are burning.

A vital point in flammable liquids safety is the prevention of the accumulation of explosive concentrations of vapors in closed off areas. (See Section 2 for a full discussion of ventilation control for toxic vapors.) Wherever either moderately or highly flammable liquids are used or stored, ventilation is a very important consideration.

The amount needed, whether natural or mechanical (fans and blowers) depends upon the materials and the conditions involved. No dependence should be placed upon the odor of the material as a warning, because some flammable vapors are heavy and tend to settle, and because smell is deceptive. The safe procedure is continual testing with an explosion or flammable vapor indicator.

Besides flammable liquid fires, the results of which can be somewhat mitigated by effective loss limitation techniques, there are two more types of disaster, protection from which is nearly entirely dependent upon prevention.

Dust Explosions

Practically any combustible, when in the form of dust and mixed with air in the proper proportion, will burn so rapidly as to cause a severe explosion if ignited by heat, a spark or flame. Ignorance of this fact has led to many serious disasters. Grain, flour, coal dust and metal powders all constitute hazards in this regard. Explosions have been known to occur in plants handling fertilizers, wood dust, powdered milk, soap powder, paper dust, cocoa, spices, cork, sulfur, hard rubber dust, leather dust and many other products. For the prevention of dust explosions good housekeeping is of the utmost importance. All equipment must be dust-tight and kept so. Explosion vents should lead outdoors to a safe location and the vent ducts themselves should be strong enough to withstand the force of the explosion. Vacuum cleaning is superior to sweeping. The use of compressed air to blow dust off equipment and thus create dust clouds should be forbidden!

Ledges, exposed piping, beams, etc., in the ceiling should be kept free from accumulation of dust. Where a dusty operation is to be installed in a location where there are piping and projections overhead, it is often erroneously considered satisfactory to install a smooth ceiling below the piping and other projections. This does not eliminate the hazard, and may intensify it; unless the ceiling is extremely well designed and carried out, dust will penetrate it and settle not only on the piping but on the upper side of the ceiling itself. Then a shock may be sufficient to fill the entire false space with a combustible dust cloud which a spark may set off. If piping cannot be relocated or eliminated, it would be better to leave it exposed and provide for a regular cleaning program.

It was for reasons such as the above that a starch dust plant recently constructed in the southwest, where weather conditions are moderate the year round, has been built of entirely open construction so that there is no confinement of the force of any explosion and the constant flow of air through the plant provides little opportunity for dust layers to build up.

As in the case of flammable liquids fires and explosions, the control of dust explosions is based upon prevention of ignition and secondarily limitation of damage in the event ignition does occur.

To prevent ignition, open flames, smoking, and cutting or welding are prohibited until the area is made dust-free. Electrical wiring should be of the type suitable for a dusty atmosphere and static electricity, too, must be eliminated. Highly dangerous materials of this sort are handled most satisfactorily in enclosed systems in which suitable inert gases are introduced into the system to replace the air normally present. This precaution is particularly applicable to the field of powder metallurgy. The kind of inert gas used must be chosen on the basis of its suitability for the operation in question.

Salt-Bath Explosions

The third type of disaster in which after-the-fact protection is much less important than prevention is the molten salt-bath explosion. There have been serious disasters involving such baths, because personnel involved on both the management and operating level failed to appreciate the potential hazards of the situation. Due to mechanical failure or man failure, or combination of both, molten salt baths have been allowed to explode. The hazards of molten salt baths may be summarized as follows:

(1) Violent generation of steam due to water introduced as "carry over" on a piece of work from a preliminary cleansing or quenching bath, condensation on overhead service piping, leaky roofs and operation of automatic sprinklers, also contact with liquid foods placed on ledges near the baths for "warming-up" by workmen.

(2) Sudden and explosive expansion of air occluded in blow-holes of castings and that trapped in tubes, closed piping, or hollow metal work when immersed in molten baths without pre-warming.

(3) Violent and uncontrollable chemical reactions between nitrate baths and carbonaceous materials such as oils, soot, graphite, and cyanide carry-over from adjacent carburizing baths.

(4) Vigorous and explosive reaction between overheated nitrate baths and aluminum alloys.

(5) Explosive reaction between normally heated nitrate baths and carelessly introduced magnesium alloys.

(6) Thermit-like reaction between aluminum alloy articles lost in bath and the iron oxide sludge blanketing and insulating the bottom of bath container.

(7) Structural failure of bath container while in operation under conditions tending to lower the normal durability; reaction between metal of bath container and nitrate due to localized overheating.

(8) Failure of temperature controls, with consequent overheating of nitrate bath.

(9) Storage and handling of bulk supply of sodium nitrate, and careless disposal and storage of waste nitrate without regard to active properties of the salt.

(10) Accidental or uninstructed setting of temperature control above safe operating limits.

The precautions for safe operation of molten salt baths are summarized as follows:

(a) Guard against the introduction of any extraneous matter.

(b) Protect completely from overheating, by automatic control and temperature readings taken at regular intervals.

(c) Isolate the operation as far as practicable.

(d) Instruct all personnel thoroughly and completely in regular and emergency procedures.

From the foregoing it can be clearly seen that the handling of flammable liquids, flammable dust or molten salt baths are the three chief operations in which prevention is the most important phase of fire protection. In each of these cases whatever action is taken after the act and whatever physical protection is provided can only furnish some degree of mitigation of loss and it is often insufficient to prevent a large-scale disaster.

LOSS LIMITATION

The other aspect of a realistic fire protection program is limitation of loss due to a fire which includes provision for the *prompt discovery* and equally *prompt extinguishment* of the fire. It is certain that everyone has at one time or another wondered why a particularly destructive fire was allowed to happen, when supposedly a great deal of effort is constantly being devoted to the prevention of such fires.

It may be that too often the prevention aspect of fire protection has been the total or nearly total effort at protection with the result that when even a small fire starts it has a good chance to become a calamity. However, even the utmost vigilance would have been of no avail in guarding against some of the fires which are on record, and once the fire has started its cause is immaterial. The cause of the loss is much more important; and the facts which determine that are the physical conditions and those measures which have or have not been taken to limit the extension of the fire.

One of the means of preventing the extension of fire is to segregate hazardous processes and storage into separate buildings. But even where hazardous processes are not involved, the concentration of too much value in one fire area must be guarded against. This is best accomplished by the erection of separate buildings, adequately spaced, which in turn presents problems of maintenance and operation. Suppose a major plant has an operation involving flammable liquids. Such processes as spray painting or dipping use tremendous quantities of flammable solvent; extraction processes and the manufacture of products of which flammable solvents are major constituents are typical examples of processes which require subdivision. The flammable liquid operations and all its appurtenances must be physically separated from the rest of the plant for maximum safety. Care should be taken that the separate buildings are no larger than production efficiency demands; in other words, only as much should be put under one roof as is necessary to be in one building. Where space or production requirements preclude separate buildings, the area in which flammable liquids are handled must be physically separated from the rest of the plant by approved fire walls or, where these are not practicable, by water-curtain type sprinklers.

Subdivision of one large risk into smaller fire areas may also be accomplished by means of fire walls which stop the spread of fire from one area to another. To accomplish this purpose the wall must be carried through the roof and either through the side walls for a distance of at least 36 inches or turned back on both ends for a distance of several feet to provide a barrier around which the fire cannot travel.

Many otherwise sound fire walls have failed due to the fact that holes were made in the walls to permit the passage of pipes, conduit, etc., and then never properly closed. Every hole in a fire wall must be sealed at the time such work is being done. The weakest point in a fire wall is the fire door provided to permit access from one section to another. At any given time a high percentage of such doors are found upon inspection to be useless as fire barriers. They must be test-operated regularly. The chief deficiencies are missing fusible links, or damage to the doors by materials handling equipment, which damage would prevent their operation, or blocking by material left in the doorway so that the door cannot close.

Proper maintenance includes regular inspection, physical guarding to prevent damage, the painting of "keep clear" lines on the floor and a constant program of education. Wherever practicable, such doors should be closed at night to insure that they will be closed in the event of fire. Where the use or occupancy of the building has changed and fire doors are not needed any longer, the openings should be bricked up to the same thickness as the original walls. Even a pair of fire doors, one on each side of the opening, is less resistant to the passage of fire than the fire wall in which they are installed. In normal operation, because of the aisle space leading to the opening, the heat on the door should be less than elsewhere in the building. If the doors are closed and contents are piled against the doors, fire may be transmitted from one side of the wall to the other. In all cases, the doors provided should be of the type approved for the opening in the wall. In many cases, doors approved for use only on vertical enclosures such as stairways are installed in fire walls and will not serve their intended purpose in the event of fire. If openings are necessary in fire walls for the passage of conveyors and no type of door installation is practical, then the openings should be specially protected by hooded automatic sprinkler heads directly over the opening on each side of the wall. A fire wall should be thought of as a dam which any small leak can cause to fail.

The spread of fire from floor to floor in a building is prevented by the proper enclosure of vertical openings such as stairways, elevators shafts and process openings through the floor. The question of stairways deserves particular comment because in so many cases self-closing stairway doors are found to be wedged open to permit easy passage from floor to floor. Such examples of poor management entirely negate the cost of closing the stairway off by providing the doors in the first place.

One of the primary reasons for enclosing stairways is to permit the passage without injury of personnel from upper floors to the street level past the floor which is on fire. If the stairway doors are wedged open this may be impossible. The stairways can immediately become choked with hot air, smoke and gases from the stairwell.

Provision of fusible link arrangements to close such doors is not very satisfactory because fumes and smoke will pass through without operating the link. In at least one laboratory the problem of stairway doors being wedged open versus the desirability of having them closed in a hurry has been solved by providing for electric latches. These latches hold all the doors open, but connected to the fire alarm system is a relay which causes all the electric locks to release when a fire alarm is sounded, thus closing the doors.

A further loss-limiting device which is useful where flammable dusts and vapors are used is the explosion vent. It is important to install explosion vents in areas where flammable liquids or dusts are used because of the possibility of great damage due to explosive ignition of such mixtures and air. Therefore, on a practical basis properly designed explosion vents are a suitable safeguard, as they reduce the chances of destruction indoors by allowing the force of the explosion to be transmitted to the outdoors.

In order to fully relieve the pressures produced by explosions in vapor and air mixtures, a vent area as large as 1 square foot for every 10 cubic feet of room volume would be necessary. However, it is unlikely that more than a fraction of the total volume of a room will at any time be within the explosive range. Therefore for a small room with a floor area of about 200 square feet, the venting area should be at least 1 square foot for each 30 cubic feet of room volume. For larger areas, this proportion may not be obtainable, but in no case should the vent area be less than 1 square foot for each 50 cubic feet of volume.

Approved explosion venting windows are available. Also, sky-lights, roof-hatches, or light windows hinged at the top and carefully installed to swing outward under even slight pressure can be useful. Under some conditions, doors equipped with releasing latches may be utilized as vents.

Furthermore, where the conservation of heat in a plant is important, and the walls of the building are otherwise of strong construction, a section of exterior wall may be built of light wood, or hollow tile or some other material which is relatively weak compared to the rest of the building so that in case of an explosion, these sections will give first.

It is important that snow or ice be kept from collecting on explosion vents so that they can operate freely in case of an explosion.

FIRE DISCOVERY AND TURNING IN THE ALARM

With the exception of such occurrences as flammable liquid explosions, dust explosions and molten salt bath explosions, most fires are quite small at first and can be readily extinguished if discovered early. Although no one would dispute the truth of this statement, it is amazing how many organizations completely ignore the fact and make no provision for the prompt discovery and sounding of an alarm, in the event of a fire.

The greatest single cause of large fires is delayed alarms. This does not necessarily mean delayed discovery; the files are replete with examples of people who discover fires and take entirely the wrong action because they had not been properly trained.

The detection of fire is too often left to chance. If it is left to the chance passerby it can be assumed that no alarm will be turned in until flames are actually leaping from the front of the building, at which a point heavy fire loss has already taken place. The best solution to this problem is an automatic fire alarm system connected to an office manned by responsible personnel on an around the clock basis. In larger installations this may be the plant's own security office; in smaller installations, the office of a private company specializing in this service. In small cities or rural locations this service can often terminate at the police station or fire house. Such an alarm system, *if properly installed and maintained,* assures that fires will be discovered and reported promptly in their incipient stages. Automatic sprinkler systems with provision for an alarm can serve the same purpose.

Most automatic fire alarm systems are of two general types; one measures the rate at which the temperature of the air rises; the other sounds an alarm when the temperature reaches a certain predetermined point. Each has its merits for a particular installation, and some types of systems combine both features. Any such system should bear the approval of Factory Mutual ~~or~~ Underwriters Laboratories.

Under some circumstances, such as the storage of furs or documents, or as in electrical equipment rooms, a slow-burning, smoldering type of fire may be expected. In such a case, neither the fixed temperature or temperature rate of rise device may function rapidly enough to transmit an alarm before serious damage has been done. A photoelectric cell device might here be used to trigger the alarm when traces of smoke pass through the light beam. Such a system also starts all necessary action, such as shutting down fans, operating dampers and transmitting the alarm. This type of protection is a "must" in the modern windowless factory which depends for its ventilation entirely upon a mechanical air-conditioning system into which the introduction of smoke at any point can cause it to be transmitted throughout the area, with consequent panic and possible loss of life.

The most ancient and still most common form of fire protection is the watchman. He is an extremely important employee. In many cases the entire physical property of an organization together with its business future is entrusted to his care over half the time. However, he is rarely chosen with these responsibilities in mind. Just as rarely is an effort made to see to it that the watchman is schooled to react automatically to take proper action if the emergency against which he was employed does occur. Too often the position is used for the semi-retirement of the superannuated employee.

Even when the watchman is hired outright, the pay scale is often so low as to attract only the completely unfit. There are scores of instances of watchmen of valuable properties who cannot write or read English and in truth can hardly speak it, who do not know how to use the dial telephone, who do not know how to turn in a fire alarm—in short who do more to present a hazard to a property than to protect it.

There are three considerations in watchman protection which cannot be overlooked: (a) selection of personnel, (2) training, and (c) supervision, The watchman should be neither too young nor too old. If too young he may lack judgment and in addition is very likely to be bored with the job. If too old he may lack the physical stamina which the job requires. He must be thoroughly and carefully trained in the proper action to be taken in the event of any emergency in the plant.

Particular stress should be laid upon obtaining assistance for the watchman before attempting to fight any fire or deal with any other dangerous emergency. Many concerns use a "watchman daily report form," which also contains an illustrated paragraph of instruction on some phase of the watchman's duties. If the watchman's service is to be performed effectively, regular routes must be laid out and means must be provided to determine that the watchman is or has been in a required location at the required time. The watchman's clock is the most familiar example of such a device, but it has a serious limitation—no check can be made until the next day.

There is no instantaneous assurance that the rounds are being made in accordance with instructions, or in the case of a single watchman in the plant, no provision for investigation, should the watchman be injured, or become ill or leave his post for any other reason.

The best type of protection is that provided by electric watchman-reporting stations; most often they are incorporated in fire alarm boxes whereby the watchman sends a signal to the supervisory office and indicates his location at the same time. If the watchman does not report at each location within the time specified, an immediate investigation can be made. In a large plant, this service would probably terminate at the plant guard-office; in the smaller plant it would be provided by a company specializing in this field.

Even when the plant is in operation, the question of sounding the alarm must not be left to chance. The fire protection organization composed of plant personnel should provide for a specific person (with a number of alternates) to turn in the alarm, and emphasis should be laid at all times on the matter of doing this promptly.

No fire department objects to being called to trivial fires. Over 95 per cent of the responses of all fire departments, large and small, are to fires which could be classed as trivial. A high proportion of the other 5 per cent could have been kept in the trivial class had the fire department been called immediately when the fire was discovered. *Delayed alarms cause fire disasters.*

EXTINGUISHMENT OF FIRE

To extinguish a fire it is necessary to remove or sufficiently lower the concentration of only one of the three requirements mentioned previously.

Normally, the removal of fuel is not considered as a practical fire-extinguishing method; however, in such cases as multiple flammable liquid tanks which are interconnected, it is often entirely practicable to pump the flammable contents of a tank which is burning at its surface to another tank, and thus extinguish the fire by leaving the burning tank nearly empty. In the main, however, fire extinguishment operates by either cooling the burning material below its ignition temperature or by cutting off its supply of oxygen. Water, foam, carbon dioxide gas, bicarbonate of soda (dry chemical) and halogenated hydrocarbons comprise the most widely used fire extinguishing media. Burning metals require special extinguishing media and techniques.

The chief problem is to determine which medium to use and in what manner. For all the media there are one or more methods of application varying both in scale and in type of operation, i.e., manual or automatic, for single spot delivery or general coverage.

Water

The oldest, cheapest, and most commonly used fire-extinguishing agent is *water*. As an example of the use of bulk or "coarse" water, an extremely effective fire extinguisher for small blazes is a pail of water. However, it is inadvisable to use bulk water on a fire involving oils, gasoline, paints or solvents; since they may be lighter than water, they will tend to be physically dispersed by the impact of a stream. As a result, the burning material will be scattered about the area and spread the fire. Moreover, no blanketing action is possible, as the oil or solvent may float on the water. Water should never be used to extinguish fires of metals which may react violently with it to cause an explosion.

Special fire pails are purchased for protective purposes; they have rounded bottoms which make them unsuitable for general service. Fifty-five-gallon used oil drums full of water equipped with two or three fire pails are practical for yard storage where the material is not piled too high, as well as for use in the early stages of construction projects before permanent water supplies are installed. Calcium chloride can be added to the water to prevent freezing during cold weather.

Water is usually most effective when applied in the form of fine droplets or spray. This has a blanketing action, and avoids the difficulty of impact-scattering of materials lighter than water. Proper fire extinguishers should always be at hand in areas where flammable solids or liquids are used or stored. Modern sprinkler systems are the most efficient means of supplying such a spray over a wide area.

Fire Extinguishers

A standard 2½-gallon soda-acid fire extinguisher provides 2½ gallons of water. When the extinguisher is inverted, a small bottle of sulfuric acid is overturned into the water in which bicarbonate of soda has been dissolved. The pressure of carbon dioxide gas so formed expels the water. Such an extinguisher requires annual recharge and must be protected from freezing. The soda-acid extinguisher is rapidly being supplanted by a type in which the carbon dioxide gas is provided by a small high-pressure cylinder which can be punctured when the extinguisher is put into operation. The water is then driven out by the gas. This type of extinguisher can be winterized by the addition of antifreeze chemicals if desired; in addition some manufacturers provide an antifreeze additive which also increases the extinguishing effectiveness of the unit. The maintenance required is an annual check on the weight of the carbon dioxide gas cylinder.

Automatic Sprinkler Systems

A properly designed, installed and maintained automatic sprinkler system is by far the most efficient fire protection device as yet produced. It is no exaggeration to state that American industry could not exist as it does today without automatic sprinklers. Statistics kept over a 50-year period by the National Fire Protection Association covering some 70,000 fires show that sprinklers extinguished or held in check 96 per cent of the fires in sprinklered buildings. Of the failures, about 1 per cent were due to water being shut off on the sprinkler system or the water supply being defective. Another 1 per cent were due to the fact that the system could not get into operation fast enough because the fire started in an unprotected portion of the building and had gained tremendous headway by the time it entered the protected section. Obstructions to distribution of the water from the sprinklers which in effect rendered at least portions of the building unsprinklered also caused some failures.

Objection is sometimes made to installing automatic sprinklers for fear that premature operation would cause excessive water damage. The possibility of a sprinkler head misoperating from defects in manufacture is negligible—only one chance in 8,400,000 per year. Premature operation from other causes can be easily prevented: from overheating and corrosion by using special sprinkler heads; from mechanical damage by installing wire guards; and from freezing by providing antifreeze solutions or by use of dry pipe systems.

A hose stream delivers the equivalent of a dozen sprinklers, whereas 5 heads or less extinguish 73 per cent of all reported fires where sprinklers operate. Sprinkler piping is tested for a pressure of at least 200 pounds per square inch before the system is accepted. No such tests apply to ordinary water piping, and the possibility of damage from a burst water pipe is therefore much greater in the case of ordinary domestic service. In addition, no sprinkler system is complete without an alarm device which notifies responsible authorities when any water flows in the system—a feature entirely lacking on domestic and process piping.

An automatic sprinkler system is essentially an arrangement of pipes throughout the protected area provided at suitable intervals with sprinkler heads equipped with fusible(wood's metal) links to release the water when the temperature at the head reaches the desired point.

Wet type automatic sprinkler systems consist of such an array of piping together with an alarm check valve which prevents back flow from the system to the water supply and provides a means whereby a local central station alarm can be received in the event there is a flow of a water in the system due to a fire or accident.

In a low building where water pressure and volume are good, the water supply may come solely from the street main. In other cases, it may be necessary to provide an elevated supply of water so that the water will be automatically available under gravity pressure. A fire department connection is provided so that the fire department can pump into the system and increase the volume of water available in the event of a serious fire. The maintenance is simple but the utmost care must be taken to make sure that there is water in the system at all times.

The equipment is designed to facilitate inspection. The outside valve leading from the street main is almost invariably a post indicator valve, that is, a valve brought up above the surface of the ground with an indicator as part of the valve, which shows whether the valve is open or shut. Interior valves are of the outside stem and yoke type (OS & Y), that is, the valve stem protrudes through the valve yoke and is visible for its full length when the valve is open. If the stem cannot be seen the valve is closed.

Seals and padlock arrangements are often used to prevent unauthorized tampering with sprinkler valves. A tag system including notification of responsible authority should be used in connection with routine work to make sure that the valves are reopened when the work is completed. If extensive alterations are necessary, they should be carefully planned so that the maximum portion of the system can be plugged off and so be kept in operation until the alterations and additions are ready to be tied back into the main system. Every effort should be made to put the system back in service to at least give partial coverage during nights and over week-ends during the period of repair. There are many instances of fires getting headway in plants which had an excellent sprinkler system which was out of service for repairs at the critical moment.

The ultimate in protection of sprinkler valves against tampering whether accidental or malicious is an electrical alarm device, attached to the valve, which will transmit a signal to a central headquarters when the valve is closed.

When alterations or new construction is planned for a sprinklered building, a part of the alteration costs must be the provision of the necessary changes, extensions or additions to the sprinkler system. An unsprinklered mezzanine constructed within the plant or an unsprinklered shed constructed outside can become so heavily involved in a fire that by the time the fire reaches the sprinklered area, the system is overpowered.

In areas subject to freezing, a *dry pipe* automatic sprinkler system may be installed. In such a system, air under pressure in the piping keeps the water from entering the unheated area through the dry pipe valve where a differential type of valve seat enables a relatively low air pressure to hold back a much higher pressure of water. Such a system requires a dependable supply of compressed air to make up any losses in air pressure due to air leakage in the system. If the air pressure fails, the system "goes wet," and an alarm will be received. In non-freezing weather the system may be allowed to remain wet for a short period of time before it is drained and the dry pipe system restored. A word of caution, however; once the system has "gone wet" no further alarm will be received from a flow of water due to the operation of a sprinkler head. During freezing weather, of course, immediate action must be taken to drain the system and restore the valve to prevent freezing. Large dry pipe systems are provided with exhaust valves to vent the air in the system quickly and thus speed up the water discharge.

When settling of a building occurs, the pitch of the piping must be carefully checked to see that all sections of the system will drain back to the valve and that no pockets are created where water may remain and cause the pipe to burst during freezing weather. A dry-pipe system necessarily operates more slowly than a wet pipe system. In the event that the situation changes and a permanent heating system is installed in the building, the sprinkler system should be converted to a wet-pipe system. Another practice that should be guarded against is the "pumping up" of the air pressure on the sprinkler system to an excessively high point to prevent the accidental tripping of the dry pipe valve because of leakage of air. By filling this system with many times the normal volume of air, a situation is created where in any emergency it may take several minutes for air to exhaust itself from the system and finally permit the flow of water from a sprinkler head. The proper way to correct air leakage is to inspect the piping, to locate and eliminate the air leaks.

Modern warehousing may present difficult new problems, such as the high piling of stock now permitted by means of mechanical handling equipment; the palletizing of material providing for horizontal and vertical spaces through the pile; and the storage of such materials as rubber tires.

Most sprinkler heads now in use project the water upward in a very fine spray; the spray pattern from the various sprinkler heads joins just below the ceiling to provide a barrier against the transmission of heat to the building proper. It is highly effective as a heat absorber, which is after all the primary purpose for using water in fire extinguishment. These new heads are by no means a cure-all, particularly for an inherently unsatisfactory situation; but they will definitely provide a higher degree of protection than has heretofore been possible in the type of occupancies discussed above.

Fire Hoses

Fire-hose lines fall into two classes: interior and exterior. Interior fire hoses are generally 1½" inside diameter with a ½" open nozzle. The water supply may come from a take-off of the sprinkler system, from domestic or process water pipes large enough to deliver a sufficient quantity of water at the required pressure or in multi-story buildings, from a standpipe system.

In multi-story buildings the standpipe system is provided because it may be used by the fire department as well. No fire hose could stand the pressure necessary to overcome the friction and gravity loss involved in delivering a stream of water to a fire at the top of a skyscraper. In addition, the time consumed for such an operation would be intolerable. Such systems generally get their primary supply of water from roof tanks; or in very high buildings from a series of tanks provided at various floor levels throughout the building. Outlets of 2½" diameter are provided for fire department use. Where the head pressure from an elevated tank would cause excessive pressure at the valve, reducing valves are installed.

Easily broken sealing devices are provided so that the fire department with its trained personnel can quickly obtain the full flow from the standpipe if desired. Unlined linen hose, air pressure-tested at the factory, is usually used. This hose should never be wet except during an actual fire, since without proper facilities for drying, it will invariably mildew and deteriorate.

Another common cause of rot in such hose is drip from valves which are not properly seated or are cracked slightly open because of tampering with the valve. Hose set in wall cabinets is much less likely to have this trouble than that exposed on open racks. When the linen hose is first used it leaks a little until its pores swell and it becomes reasonably water-tight. For its purpose, however, it is superior to cotton, rubber-lined hose because of the smaller space required for storage and the small amount of maintenance required as long as the hose is kept dry.

For outside use 2½-in. cotton, rubber-lined hose is standard. Hose should be double-jacketed to be able to stand maximum wear. Because of the minimum amount of attention usually accorded hose in the average industrial plant, mildew-proof hose should be purchased. Its higher initial cost will be more than offset by the longer maintenance-free service to be expected from it. Such hose is provided either mounted on wheeled carts which will carry about 500 feet together with nozzles, wrenches, etc., as a compact unit, or in wooden structures or hose houses built around the fire hydrant to provide protection for several hundred feet of the hose attached to the hydrant and about 300 more feet in reserve in the hose house. The hose house is also used for the storage of other emergency equipment. Building and equipping individual hose houses has become increasingly expensive.

When the type of hazard demands heavy-duty outside fire protection, and the organization of a thoroughly trained brigade, serious consideration should be given to the provision of fewer strategically located hose reels and the elimination of hose houses. For the cost of several hose houses a light weight truck can be purchased and readily adapted as a hose and equipment carrier, thus providing greater flexibility and ease of maintenance at lower cost.

Foam

Another important type of fire-extinguishing material is *foam*. Most foam installations are small enough to be portable and very effective on fires covering a relatively small area. There are a few installations, however, which have installed permanent piping to bring foam to bear on relatively large areas of acute fire hazard. Foam is particularly important in the case of liquids which are lighter than water which would float on the surface of the water and spread out, carrying the fire to points beyond which it originated. Chemically this foam is often produced by bubbling carbon dioxide or some other gas through a liquid containing a foam-producing chemical. The hard resilient bubbles of foam thus formed coat a burning surface with what is essentially the gas used to bubble through the liquid in the first place, and if this gas is carbon dioxide it effectively smothers the fire by preventing access of oxygen.

Other Agents

Still another technique for fire extinguishment is the use of carbon dioxide, dry chemical and halogenated hydrocarbons such as carbon tetrachloride or methyl bromide. Here a portable extinguisher of carbon dioxide or dry chemical type is applicable to relatively small fires. Large scale protection would require permanentally piped carbon dioxide systems so that enough gas can be brought to bear on the burning mass to smother it effectively. As to the use of halogenated hydrocarbons it must be remembered that when the most commonly used members of this group are heated to high temperatures they decompose and evolve highly toxic decomposition products. In the case of carbon tetrachloride, one of the decomposition products is the well known poison, phosgene. However in the case of a fire where the ventilation is relatively good, it may be advisable to put up with the comparatively small amount of phosgene formed in order to put out the fire quickly and effectively. An ideal example of where not to use halogenated hydrocarbon types of fire extinguishers is in public conveyances where many people might be trapped, such as a subway train without adequate ventilation. The use of halogenated hydrocarbon fire extinguishers should be restricted to relatively small fires in well ventilated areas.

Gas Fires

The extinguishment of gas fires may be carried out with carbon dioxide, dry chemical or in some cases with water spray. But it must be borne in mind that if the gas fire is put out and the gas supply is not shut off, the gas will continue to pour out, ultimately filling a large room or building with a flammable or even explosive mixture which upon ignition could cause more damage than the original burning gas. The best method of handling gas fires is to stop the flow of the gas. If this cannot be done at once, it is often wise to simply spray the surrounding area and surfaces with water to keep them cool and thus prevent their ignition until the supply of gas is exhausted or a valve controlling the flow can be closed.

Burning Metals

Fires caused by burning metals are very difficult to extinguish and cannot be handled in the ordinary manner. For instance, to spray water upon burning metal might cause an explosion which would spatter flaming particles of metal to great distances. Usually the best way to attack burning metal is with specially formulated dry-type fire-extinguishing agents. For instance, when one is planning to use a metal in a form in which it might readily become ignited, it is wise to discuss the situation with the manufacturer or supplier of this metal and obtain from him explicit instructions upon the storage, handling, and fire extinguishment of the metal. This is particularly applicable to the use of sodium, potassium, lithium, zirconium, uranium, thorium and magnesium. For instance, it has been found that ordinary sand,even when dry, is a very poor material for extinguishing metal fires; it may react with the hot metal and add more heat to an already intense fire. Often salt (sodium chloride), sodium bicarbonate, graphite, magnesium carbonate, magnesium oxide or mixtures of all of these materials have been found effective; in every case the supplier of this material will know how it must be handled. Water should never be applied to fires of metals.

INTANGIBLE LOSSES DUE TO FIRE

While ordinary fire insurance may pay the dollar losses incurred in a fire, and insurance coverage may also be provided for the loss of profit during the shutdown period, what protection is there against the loss of market and the fact that customers unable to be supplied may turn to a competitor?

When it seems that all the normal precautions have been taken and that there is a generally good level of protection throughout a plant, it is necessary to consider the entire operation and determine if there are bottlenecks where a relatively minor loss could result in a severe one by a consequent shutdown in production. This may be within the organization or elsewhere in the production chain. Power supply, for instance, is an extremely critical item. Inquiry should be made of the local utility to determine just how dependable it is. Should the local utility have a serious breakdown in its own facilities, arrangements should be made for possible connections to a utility grid in order to continue an uninterrupted flow of power.

Many areas experience periodic shortages of natural gas, during which industrial organizations must conserve its use in order that more may be available for home heating. If such fuel is used, arrangements should be made for the emergency use of liquefied petroleum gas. Safety should be provided for in advance; if precautions are improvised at the last minute, unnecessary risks may be taken. As to utility arrangements, transformers and other substation equipment should be adequately guarded against damage or destruction from fire in the plant.

Another very important source of serious loss results from destruction of records. The old iron safe in the treasurer's office does not represent adequate protection for the vital records it contains, should there be a destructive fire. The Underwriters Laboratories and the Safe Manufacturers Association test and label safes and cabinets for their fire resistance. Very often we find that while some documents easily recognized as vital are well protected, those considered to be just ordinary "business records" are housed in sheet metal filing cabinets which are no more protection than wood in the event of a severe fire. The loss of Accounts Receivable records can be disastrous; and other records, even though not directly concerned with the collection of payments and accounts, may require reconstruction in the event of loss. Also, an accurate proof of loss is necessary for the prompt and proper payment of insurance claims. If the records supporting such a proof of loss have been destroyed, it may be necessary to resort to litigation or accept a lesser figure because of lack of proof.

Engineering drawings of the plant and its equipment may be almost priceless, especially when they relate to underground or otherwise concealed installations.

Provision of fire-safe record cabinets is in itself not enough; precaution must be taken to close the files and record containers in the event of a fire. Normally, in case of fire employees would immediately evacuate the area without any attention to this important detail, which would render the entire installed protection useless during the working day. The production chain should further be carefully surveyed for vital bottlenecks which might be subjected to fire loss due to the type of operation, or due to their exposure to other fire-producing potentials. The protection provided should be thoroughly considered to determine whether or not it is adequate under the circumstances. If adequate protection for one reason or another is unduly costly, a study should be undertaken to determine where else the work could be carried on if the operation were wiped out. In some cases it may be cheaper to assume the risk, because in the event of a fire the work could be contracted out to other organizations in the vicinity with similar facilities. Or it may be found that such an arrangement would be impractical and that the loss of, e.g., the spray painting and detearing steps would completely shut down production; continuity of production might then best be protected by rearranging the area and subdividing it with fire walls so that only a portion of the facilities could be destroyed at any time.

Having examined the production bottlenecks in a plant and determined the best way with which each one must be dealt to prevent it from shutting down production, it is necessary to examine the situation with respect to suppliers. It is quite a shock to receive word that the XYZ Corporation has burned to the ground, and then realize that it was the sole supplier of an important subassembly of one's production and that there is only a single week's inventory on hand. When subcontracts for any portion of production are undertaken, it is necessary to consider the sub-contractor's plant in the same light as one's own. There is no reason why this matter cannot be brought out during the contract negotiations; but even prior to this time, a discreet survey of the situation can be made in connection with the ordinary inspection of his facilities. If the situation looks dangerous, the least precaution that should be taken is to divide up the subcontract and allow a portion of it to another contractor, thus spreading the risk. Or one might advance his delivery schedule to provide himself with a larger inventory.

Then there is the question of storage. Many industrial organizations produce the year round at a relatively steady rate to meet the requirements of a seasonal market. This requires the utilization of storage space often not available at one's own plant. And in too many cases storage space is leased with little or no inquiry into the fire safety of the situation, with the result that months of production effort can go up in smoke and a market may be lost forever. Here again, the basic principle of subdivision should be employed to the fullest extent practicable, even though this may involve some inconvenience and expense.

For Bibliography, see pages 169-170.

SECTION 7

STORAGE AND HANDLING OF HAZARDOUS MATERIALS

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Due to the wide range of materials which have to be stored in factories, laboratories and warehouses, good storage practice has become very important and is steadily becoming more so. Economically, it is probably not feasible to store each item of inventory in an environment which is ideally safe. It is therefore necessary to group items for storage in such a way that the best use is made of available space. To effect a compromise between perfect safety and the competitive demands of industrial economy, a source of information is necessary. The description of each material listed in Section 10, for instance, contains as much of this information as was judged to be reliable and useful for the purposes of this book.

The disastrous effects of neglecting the physical and chemical properties of stored materials are fires, explosions, emission of toxic gases, vapors, dusts and radiation, and various combinations of these effects.

In order to make it possible to discuss most of the materials with which we are concerned, we shall group the many thousands of individual items into categories as follows:

(1) **Explosives:** Materials which under certain conditions of temperature, shock or chemical action can decompose rapidly to evolve either large volumes of gas, or so much heat that the surrounding air is forced to expand very rapidly; in either case an explosion results. These materials are particularly dangerous when involved in shock or heat-producing disaster conditions. Appendix 1 to this section discusses in detail the storage, handling and disposal of explosives.

(2) **Flammable Materials.** Practically all combustion takes place between oxygen and a fuel in its vapor or some other finely divided state. Thus, in order to start a solid burning it is necessary to heat at least a portion of it to a point where enough vapor is evolved to catch fire. Since at a given temperature liquids are generally at a higher vapor pressure than solids, flammable liquids are usually easier to ignite than flammable solids. Flammable gases are usually very easy to ignite. Flammable dusts are about as easy to ignite as vapors or gases.

A further, quantitative, difference exists between propagation rates of solid, liquid and gas fires. Fires of solids propagate slowly; fires of liquids propagate relatively rapidly; and gas, vapor or dust fires propagate so rapidly they often seem to explode.

Section 10 contains several thousand materials of varying degrees of flammability listed in alphabetical order. In each case where sufficiently reliable data are available the degree of fire hazard of the material is indicated.

Materials which ignite easily under normal industrial conditions are considered to be dangerous fire hazards. For instance, pyrophoric substances such as finely divided metals, hydrides of boron, and phosphorus; liquids with flash points of 80°F or lower; and flammable gases. Such materials must be stored in places that are cool enough to prevent accidental ignition in the event that vapors of the fuel mix with the air. It is important to provide adequate ventilation in the storage space, so that normal leakage of such vapors from containers will be diluted enough to prevent a spark from igniting them. A further precaution is to locate the storage area well away from areas of fire hazard, such as where torch cutting of metals is performed, etc. Highly flammable materials must be kept apart from powerful oxidizing agents, materials which are susceptible to spontaneous heating, explosives or materials which react with air or moisture to evolve heat.

Ample fire fighting equipment, either automatic or manual, must be readily available for emergency use. The storage area must be posted to prevent smoking or striking of matches. Bare filament heaters or other sources of ignition must be kept away. The area must be electrically grounded and periodically inspected or equipped with automatic smoke or fire detection equipment (see Section 6).

All combustible materials are dangerous in a fire and/or explosion, both because heat will cause them to catch fire and add to the smoke and fume hazard, and because small explosions have been known to scatter clouds of flammable dusts which in turn have caused still greater explosions than the original one which gave rise to them. See Appendix 3 to this section (p. 166).

(3) **Oxidizing Agents.** Oxidizing agents are sources of oxygen, one of the necessary components of a fire. Normal air with its 20% content of oxygen is the primary source. However, many other materials are so constituted chemically that they can supply oxygen to a reaction, even in the absence of air. Some of these oxygen suppliers require heat before they will yield oxygen; others evolve significant amounts of it at room temperature. When containers of oxidizing materials are damaged, for example, in a disaster, their contents can mix with the contents of other damaged containers and possibly start fires and explosions. This is a strong argument in favor of *separate* storage over *mixed* storage. The following classes of compounds are noted for their ability to supply oxygen: peroxides, organic and inorganic; oxides; permanganates; perrhenates; chlorates; perchlorates; persulfates; nitrites, organic and inorganic; nitrates, organic and inorganic; iodates; periodates; bromates; perselenates; perbromates; chromates; dichromates; ozone; perborates.

In Section 10 each compound which is an oxidizing agent is rated as to whether it is merely an oxidizer or a powerful oxidizer. It is important to know this when planning storage of materials, because powerful oxidizers can react with oxidizable materials more rapidly than weak ones.

In general, it is unsafe to store powerful oxidizers close to liquids of low flash point. In fact, even slightly flammable materials should be isolated from oxidizers. For instance, ordinary glycerol and potassium permanganate, when simply blended at room temperature for a few minutes, react violently to produce a hot fire.

As a general rule, it is wise to keep all flammables away from an area where oxidizing agents are stored. This storage area should be kept cool and ventilated, and should be fireproof. Normal fire fighting equipment is less useful here, since the blanketing or smothering effect of fire extinguishers is less effective because the oxidizers supply their own oxygen. With these materials it is best to keep fuel away.

(4) **Water-Sensitive Fire and Explosion Hazards.** These are materials which react with water, steam or water solutions to evolve heat, flammable gases or explosive gases. Examples of such materials are: lithium; sodium; potassium; calcium; rubidium, cesium; alloys and amalgams of above; hydrides; nitrides; sulfides; carbides; borides; silicides; tellurides; selenides; arsenides; phosphides; acid anhydrides; concentrated acids or alkalies.

Of the above list, the first eight are materials which react more or less exothermally with moisture and evolve hydrogen gas (See Section 10, Hydrogen); the next nine (nitrides through phosphides) react more or less rapidly with moisture to evolve volatile, flammable, sometimes spontaneously flammable and/or explosive hydrides. Acid anhydrides and concentrated acids or alkalies react with moisture to evolve heat. Such materials must be stored in well ventilated, cool, *dry* areas. Because many of these materials are also flammable, it is essential that NO automatic sprinkler system be used in a storage area which houses them; in fact such an area should have no water coming into it at all. Heating may be electrical or with hot, dry air. The building must be waterproof, located on high ground, and separated from other storage. This building should conform to that required for storage of hydrogen.

Particular attention must be paid to the following: pocketing of light gases under the roof; introduction of sources of ignition; periodic inspection; automatic detection and alarm due to dangerous concentrations of flammable gases.

Since many disasters cause wetting of extensive areas either by flooding (if that is the nature of the disaster) or by breaking of water pipes, sprinkler systems or possibly by damaging the warehouse so that rain can get in, it is important that the items listed above receive special storage consideration for protection against disasters. See Appendix 3 to this section (p. 166).

(5) **Fire and Explosion Hazards of Acid- and Acid Fume-Sensitive Materials.** These are materials which react with acid and acid fumes to evolve heat, hydrogen, and flammable and/or explosive gases. Examples are: lithium through phosphides in the foregoing list; concentrated alkalies; metals (including structural alloys); arsenic, selenium, tellurium and cyanides. Therefore it follows that acids should not be stored in close proximity to these materials. If, however, such storage is contemplated the following precautions are called for: the area must be kept cool; it must be ventilated and periodically inspected; sources of ignition must be kept away; construction as for hydrogen storage is required.

In fact, keeping in mind that acid and/or acid fumes can attack structural alloys and evolve hydrogen, acid storage might well be in ventilated wooden sheds. Or if metal is used in construction, it should be painted or otherwise rendered immune to attack by acid. If hydrogen may be evolved, the building should be so constructed that possible hydrogen pockets are eliminated.

Disaster conditions of high temperatures, much vibration and/or flooding can bring acids or acid fumes into contact with lithium, sodium, potassium, calcium, and rubidium; unless a good deal of thought has gone into the problem of storing such materials far enough apart to avoid this, fires and explosions may result. See Appendix 3 to this section (p. 166).

(6) **Compressed Gases.** Tanks of compressed gases should be stored upright, and chained or otherwise securely attached to some substantial support to minimize the chance of falling over and breaking, straining the valve or other part of the tank. The tank storage area should be kept cool, out of the direct rays of the sun, away from hot pipes, in a ventilated area where care has been taken in construction so that pocketing of gases which may escape from their containers will be kept to a minimum.

The building which houses the tanks should be fire-proof. It should provide some means (such as a sprinkler system) of keeping the tanks cool in case of external or internal fire. The reason for concern about overheating is that this will raise the pressure of the gas in the tank to the point where the safety disc or a valve might rupture, thus releasing a significant volume of say, hydrogen or acetylene, which might then catch fire and possibly explode.

While it is true that today the handling of compressed gas tanks is relatively safe due in great part to engineering improvements and standardization of components, certain precautions are still advisable. Aside from upright, cool storage, care must be taken to keep from damaging tanks in handling; valves must be operated carefully and kept in good condition. Avoid drastic changes in temperature; do not hammer valve cocks; keep valve cover on whenever possible; do not interchange reduction gauges from one gas to another without checking for compatibility; discourage tampering with tanks in any way; put tank storage in charge of personnel competent to handle it. For further information on compressed gas tank storage consult the Compressed Gas Association of New York City, your gas supplier or your local fire department.

Disaster conditions including high ambient temperatures due to nearby fires, shock and vibration due to nearby explosions, etc. are particularly trying for compressed gas storage. Great care should be exercised in the storage of large quantities of compressed gases, particularly in areas of high population density. See Appendix 3 to this section (p. 166).

(7) **Toxic Hazards** are materials which under either normal conditions or disaster conditions or both can be dangerous to living things around them. Thus carbon tetrachloride, for example, if stored in a poorly ventilated place under standard conditions can evolve enough vapor to render the storage area toxic. Under disaster conditions of high temperature, if carbon tetrachloride is decomposed it can form significant quantities of the highly toxic phosgene.

Since it is nearly impossible to seal containers perfectly, it is always to be expected that some of whatever volatile materials are stored will escape into the atmosphere of the storage area. Likewise, air, atmospheric moisture, and carbon dioxide will come into contact with the contents of imperfectly sealed containers. Some initially well sealed containers will build up enough internal pressure to break a seal or even burst the sealed unit.

Materials which are toxic because of their radioactivity are also included in this category. Such materials are dangerous if allowed to become air-borne contaminants, or to be ingested or inhaled into the body. Thus under normal storage conditions, small amounts of radioactive materials may escape their containers and contaminate the atmosphere; under disaster conditions such as high temperatures, severe shocks, floods either singly or in combination, they can burst containers and volatilize by heat or scatter by the force of an explosion or spread about by means of flood waters much larger quantities of radioactive materials. Furthermore, it must be borne in mind that sources of radiation enclosed in lead shielding can become dangerous in a disaster because disaster conditions can melt the shield or volatilize a radioactive material. See also Section 5, Section 8, and Appendix 3 to this section (p. 166).

In general, materials which are toxic as stored or which can decompose into toxic components due to contact with heat, moisture, acids or acid fumes, should be stored in a cool, well-ventilated place, out of the direct rays of the sun, away from areas of high fire hazard, and be periodically inspected and monitored. Incompatible materials should be isolated from each other.

(8) **Corrosive Materials.** Corrosive materials include acids, acid anhydrides and alkalies. Such materials often destroy their containers and get into the atmosphere of a storage area; some are volatile, others react violently with moisture. Acid fumes react to evolve toxic fumes with sulfides, sulfites, cyanides, arsenides, tellurides, phosphides, borides, silicides, carbides, fluorides, selenides; they liberate hydrogen upon contact with metals and hydrides. Alkalies may liberate hydrogen upon contact with aluminum, etc. Acid mists or fumes corrode structural materials and equipment and are toxic to personnel. Such materials should be kept cool, but well above their freezing points. Acetic acid, for instance, can freeze in an unheated room, and crack a glass container. There should be sufficient ventilation to prevent accumulation of fumes, and regular inspection. Containers of corrosive materials should be carefully handled, kept closed and labelled. All exposed metal in the vicinity of such storage should be painted and checked for weakening by corrosion. Corrosive materials should be isolated from materials noted above (cyanides, sulfides, etc.), reaction with which can produce highly toxic fumes.

It should be added that strong acids and alkalies will cause serious burns and eye damage to personnel, and hence adequate protection in the form of gloves, aprons, goggles, etc. should be worn when handling them into and out of storage areas. See Section 3.

Some examples of materials which warrant special care in storage are: alkali metals; calcium; acid anhydrides; concentrated acids; concentrated alkalies; arsenic; arsenic compounds; beryllium; beryllium compounds; borides; phosphides; phosphorus; silicides; cyanides; nitrides; nitrates; nitrites; sulfur; sulfides; tellurium; tellurium compounds; selenium; selenium compounds; carbides; halogenated hydrocarbons; mercury; mercury compounds; lead; lead compounds; cadmium; cadmium compounds; etc.

Storage of significant quantities of any of the above materials should be brought to the attention of the safety director of the plant owning the material, the local fire department and the local Civil Defense headquarters.

The term "significant quantity" is a difficult one to define. In an unventilated room even one pound is significant, while in well ventilated storage areas 100 to 1000 pounds may be significant, particularly to a safety director and a fire department. Ton lots and over are of concern to Civil Defense authorities, as well as fire departments and safety directors. In Section 10 of this book, the disaster hazard potential of many materials listed there is given. Often indicated are the most toxic products of the materials and the disaster conditions which might release them. Naturally, the decomposition of complex materials yields a number of products and it is beyond the scope of this book to list them all. However, when at least one toxic material is known to be formed, that one is listed. Often the product listed is not the one formed in the greatest abundance. An effort has been made to list at least one product of toxicological significance.

Appendix 3 to this section discusses in some detail the problem of planning in advance for the time when a combination of circumstances approximating a disaster might occur to an industrial installation.

A disaster can occur to a plant from without due to a flood, fire, bombing or earthquake, or from within, due to fire or explosion.

Whatever the cause, the effects are much the same and the information in Appendix 3 will be found to apply.

Handling of Toxic and Corrosive Materials

When loading, transporting or unloading such materials, HANDLE CONTAINERS CAREFULLY! Damaged drums may leak, and leaking fluid in an enclosed space may cause dangerous concentrations of vapors or caustic burns.

IF A LEAKY CONTAINER IS DISCOVERED, put on protective clothing (see below). After thoroughly airing out the space, enter and turn the leaking container on its side or end to stop the leak. Block or rope off the contaminated area and post with DANGER signs. Then report the leak immediately to your safety department or to the supplier. Wire or phone and report the following information:

1. What is leaking? (See drum label.)
2. Where is the leaky container now located?
3. Where can you be reached for instructions? (Give phone number or address for telegram.)
4. Has anything or anybody been contaminated by the spilled material? (If any persons are contaminated, call a local doctor.)

Finally, be sure that the affected area will be properly guarded in your absence by a responsible person until necessary instructions are received.

Before you open a container or handle a toxic or corrosive material in any way, PUT ON COMPLETE PROTECTIVE CLOTHING. Because your *eyes* could be harmed, you should wear goggles (or a plastic face shield). Since you could be poisoned by breathing vapors or getting the poison into your *mouth*, you should wear an effective respirator. Since many poisons can be absorbed through the *skin*, you should wear a clean cap, clean rubber gloves (rubber can absorb dangerous amounts of poison after prolonged use), rubber boots and coveralls which enclose your neck.

Drum Handling: HANDLE DRUMS CAREFULLY! Don't cause leaks. Store and use drums in a cool, well ventilated area. Do not store drums near steam pipes, boilers or other sources of heat.

To Open Drums: Set the drum under a ventilated hood with the bung end up. Unscrew the bung slowly to gradually release any internal pressure. Then fit a valve in place of the top bung. Be sure it is tight. Now tip the drum on its side with the side bung up and fit another valve in place. Be sure that both connections are leak proof. Support the drum in its cradle with one valve uppermost.

To Empty Drum: Connect the upper valve to an open air vent pipe. Connect the other valve to a closed system storage or processing unit. Watch for leaky connections and correct immediately if found. IF LIQUID SPILLS, absorb spillage with dry clay or sawdust. Bury or burn these sweepings. (Avoid the smoke. It may carry poisonous vapors.) Scrub the spill area with soda ash and soap. Flush this thoroughly and repeat the operation as often as necessary to destroy or remove as much of the poison as possible. *Don't track spilled poisons around.*

To Discard Empty Drums Safely: NEVER USE CONTAMINATED DRUMS FOR ANYTHING ELSE no matter how clean they seem to be. Empty drums must be decontaminated and disposed of as follows: (1) Thoroughly scrub out the open drum with hot water and soda ash or 5% caustic solution. (2) Flush and wash again until as much as possible of the poison has been removed. (3) To be sure drums are *not* re-used, perforate sides, top and bottom before discarding. (4) For greater safety burn out the perforated drum (avoid the smoke) before finally dumping it in a safe area. Rain water may rinse traces of poison out of a drum onto soil or into drainage streams where the poison could eventually reach animals, fish or even humans. Take no chances of this in drum disposal. Perform all operations carefully and with thoroughness.

Appendix 1

EXPLOSIVES

Explosives are shock-sensitive to varying degrees. (See Explosives, High in Section 10 for exact data.) Explosives manufacturers as well as other organizations have issued numerous recommendations as to safe and effective storage. The Institute of Makers of Explosives* has published a pamphlet, "Standard Storage Magazines Recommended by the Institute of Makers of Explosives" and has also issued the "American Table of Distances, Specifying Distances to be Maintained between Magazines for Explosives and Inhabited Buildings, Public Railways, and Public Highways." In addition, the Institute has issued a pamphlet entitled "Suggested State Law Compiled by Institute of Makers of Explosives," which has been the foundation of the law of at least some states with respect to explosives.

Those in close contact with explosives are of the opinion that conditions of storage largely determine not only the safety but also the efficiency that may be expected when explosives are used. Extremes of heat or cold, of air dryness, or of moisture in storage, the roughness or carefulness with which handled, the length of time stored, the length of time out of their original container before used—these and many other considerations have a vital influence on the behavior of a commercial explosive. The manufacturers issue pamphlets in connection with their products, and many excellent suggestions are made with respect to the safe and efficient transportation and storage as well as use of explosives; a particularly informative pamphlet entitled "Safety in the Handling and Use of Explosives" was issued by the Institute of Makers of Explosives under the auspices of representative explosives manufacturing organizations of the United States.

The Bureau of Mines of the U. S. Department of Interior has issued much information about the testing, transportation, storage and use of explosives in the mining and allied industries, but more especially with respect to coal mining. The information has been published in numerous pamphlets (Bulletins, Technical Papers, Reports of Investigations, and Information Circulars), many of which are now out of print. Other publications on explosives can be obtained from the Superintendent of Documents, Washington, D. C.; Reports of Investigations can be obtained from the Bureau of Mines, United States Department of Interior, Washington, D. C. Safety in the use of explosives is treated in publications of the National Safety Council, the American Standards Association, as well as in various other technical journals.

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Location and Construction of Magazines

Magazines should be situated far enough away from other buildings or vital structures so that in case of an explosion in the magazine the least possible damage will be done to buildings or persons in the surrounding area. Some states and cities have laws or regulations that specify this distance. Where such laws do not exist, it is recommended that, insofar as feasible, the magazine location comply with the American Table of Distances (Table 1).

The mandatory regulations as to the location of surface magazines under the Federal Explosives Act state (as of June 1, 1944):

> **Section 24 (c) (4).** All storage magazines must be properly constructed, safely located, and securely locked.
>
> **Section 25 (b) (2).** Location of Box-type Magazines. Box-type magazines, when located outside a building, shall be securely anchored. No magazine shall be placed in a building containing oil, grease, gasoline, waste paper, or other highly flammable materials nor shall a magazine be placed less than 20 feet from a stove or furnace or open fire or flame, or less than 5 feet from other sources of external heat.

In the administration of the Federal Explosives Act, it is also recommended that surface magazines be detached from other buildings in conformity with the American Table of Distances and that they not be nearer than 200 feet from any power plant, hoist-house, mill, dam, or other vital structure or to any mine shaft, tunnel, or slope-opening at the surface. In other words, the magazine should be at least 200 feet from any mine structure or opening, and the explosives and detonator magazines should be at least 100 feet apart if not barricaded, or 50 feet if barricaded. Barricading is defined in Table 1.

The magazine site should be selected with the thought of safety and protection as well as economy of operation. The topography of the ground should be carefully considered to take full advantage of protection offered by hills, rock-ledges, soil-banks, dense woods or forests, etc. A site on sandy soil is preferable to one on rocky ground, though rock-ledges can afford considerable protection. Wooded regions are highly desirable, but precautions must be taken against brush or other fires.

The site should have a good drainage to prevent dampness or moisture from penetrating the magazine. Dugouts and tunnels in the sides of hills offer good protection for the storage of explosives, but are not recommended unless they can be well-ventilated and well-drained.

In brief, the magazine should be located so that in the event of an explosion there would not be serious damage to life and property. It should also be located so as to prevent damage to or deterioration of explosives because of dampness or unduly high or low temperatures; although the magazine should be so isolated by natural or other barriers as to minimize loss of life or property in the event of an explosion, it should not be so far away that its contents could be stolen by mischievous persons.

An artificial barricade should consist of a constructed mound of earth or sand-fill with a minimum width of three feet at the top. One or more of

TABLE 1

AMERICAN TABLE OF DISTANCES FOR STORAGE OF EXPLOSIVES

As Revised and Approved by The Institute of Makers of Explosives

September 30, 1955

Explosives		Distances in Feet When Storage Is Barricaded			
Pounds Over	Pounds Not Over	Inhabited Buildings	Passenger Railways	Public Highways	Separation of Magazines
2	5	70	30	30	6
5	10	90	35	35	8
10	20	110	45	45	10
20	30	125	50	50	11
30	40	140	55	55	12
40	50	150	60	60	14
50	75	170	70	70	15
75	100	190	75	75	16
100	125	200	80	80	18
125	150	215	85	85	19
150	200	235	95	95	21
200	250	255	105	105	23
250	300	270	110	110	24
300	400	295	120	120	27
400	500	320	130	130	29
500	600	340	135	135	31
600	700	355	145	145	32
700	800	375	150	150	33
800	900	390	155	155	35
900	1,000	400	160	160	36
1,000	1,200	425	170	165	39
1,200	1,400	450	180	170	41
1,400	1,600	470	190	175	43
1,600	1,800	490	195	180	44
1,800	2,000	505	205	185	45
2,000	2,500	545	220	190	49
2,500	3,000	580	235	195	52
3,000	4,000	635	255	210	58
4,000	5,000	685	275	225	61
5,000	6,000	730	295	235	65
6,000	7,000	770	310	245	68
7,000	8,000	800	320	250	72
8,000	9,000	835	335	255	75
9,000	10,000	865	345	260	78
10,000	12,000	875	370	270	82
12,000	14,000	885	390	275	87
14,000	16,000	900	405	280	90
16,000	18,000	940	420	285	94
18,000	20,000	975	435	290	98
20,000	25,000	1,055	470	315	105

TABLE 1 (continued)

AMERICAN TABLE OF DISTANCES FOR STORAGE OF EXPLOSIVES

As Revised and Approved by The Institute of Makers of Explosives

September 30, 1955

Explosives		Distances in Feet When Storage Is Barricaded			
Pounds Over	Pounds Not Over	Inhabited Buildings	Passenger Railways	Public Highways	Separation of Magazines
25,000	30,000	1,130	500	340	112
30,000	35,000	1,205	525	360	119
35,000	40,000	1,275	550	380	124
40,000	45,000	1,340	570	400	129
45,000	50,000	1,400	590	420	135
50,000	55,000	1,460	610	440	140
55,000	60,000	1,515	630	455	145
60,000	65,000	1,565	645	470	150
65,000	70,000	1,610	660	485	155
70,000	75,000	1,655	675	500	160
75,000	80,000	1,695	690	510	165
80,000	85,000	1,730	705	520	170
85,000	90,000	1,760	720	530	175
90,000	95,000	1,790	730	540	180
95,000	100,000	1,815	745	545	185
100,000	110,000	1,835	770	550	195
110,000	120,000	1,855	790	555	205
120,000	130,000	1,875	810	560	215
130,000	140,000	1,890	835	565	225
140,000	150,000	1,900	850	570	235
150,000	160,000	1,935	870	580	245
160,000	170,000	1,965	890	590	255
170,000	180,000	1,990	905	600	265
180,000	190,000	2,010	920	605	275
190,000	200,000	2,030	935	610	285
200,000	210,000	2,055	955	620	295
210,000	230,000	2,100	980	635	315
230,000	250,000	2,155	1,010	650	335
250,000	275,000	2,215	1,040	670	360
275,000	300,000	2,275	1,075	690	385

Notes for Table 1

Note 1. "Explosives" means any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion, i.e., with substantially instantaneous release of gas and heat, unless such compound, mixture, or device is otherwise specifically classified by the Interstate Commerce Commission.

Note 2. "Magazine" means any building or structure, other than an explosives manufacturing building, used for the permanent storage of explosives.

(Continued)

Notes for Table 1 (continued)

Note 3. "Natural Barricade" means natural features of the ground, such as hills, or timber of sufficient density that the surrounding exposures which require protection cannot be seen from the magazine when the trees are bare of leaves.

Note 4. "Artificial Barricade" means an artificial mound or revetted wall of earth of a minimum thickness of three feet.

Note 5. "Barricaded" means that a building containing explosives is effectually screened from a magazine, building, railway, or highway, either by a natural barricade, or by an artificial barricade of such height that a straight line from the top of any sidewall of the building containing explosives to the eave line of any magazine, or building, or to a point twelve feet above the center of a railway or highway, will pass through such intervening natural or artificial barricade.

Note 6. When a building containing explosives is not barricaded, the distances shown in the Table should be doubled.

Note 7. "Inhabited Building" means a building regularly occupied in whole or in part as a habitation for human beings, or any church, schoolhouse, railroad station, store, or other structure where people are accustomed to assemble, except any building or structure occupied in connection with the manufacture, transportation, storage, or use of explosives.

Note 8. "Railway" means any steam, electric, or other railroad or railway which carries passengers for hire.

Note 9. "Highway" means any public street or public road.

Note 10. When two or more storage magazines are located on the same property, each magazine must comply with the minimum distances specified from inhabited buildings, railways, and highways, and in addition, they should be separated from each other by not less than the distances shown for "Separation of Magazines," except that the quantity of explosives contained in cap magazines shall govern in regard to the spacing of said cap magazines from magazines containing other explosives. If any two or more magazines are separated from each other by less than the specified "Separation of Magazines" distances, then such two or more magazines, as a group, must be considered as one magazine, and the total quantity of explosives stored in such group must be treated as if stored in a single magazine located on the site of any magazine of the group, and must comply with the minimum of distances specified from other magazines, inhabited buildings, railways, and highways.

Note 11. The Institute of Makers of Explosives does not approve the permanent storage of more than 300,000 pounds of commercial explosives in one magazine or in a group of magazines which is considered as one magazine.

Note 12. This Table applies only to the manufacture and permanent storage of commercial explosives. It is not applicable to transportation of explosives, or any handling or temporary storage necessary or incident thereto. It is not intended to apply to bombs, projectiles, or other heavily encased explosives.

Note 13. All types of blasting caps in strengths through No. 8 cap should be rated at 1 ½ pounds of explosives per 1,000 caps. For strengths higher than No. 8 cap, consult the manufacturer.

the sides should be supported by a concrete, timber or masonry wall.

Barricades. The location and construction of magazines and the use of barricades to minimize destruction of life and property should the contents of the magazine be detonated are closely related. Magazines should be protected by barricades, either natural or artificial, regardless of their distance from other buildings. The distances given in Table 1 should be used in choosing a site and should be doubled where the magazine is not screened or protected by natural or artificial barriers or barricades. An efficient barricade will limit or control the forces of an accidental explosion by diverting them upward and by shortening the trajectories of flying fragments. In some cases, it is not practical or even possible to separate magazines the required distances; but the danger can be greatly minimized by building efficient barricades.

The choice of a barrier will be governed largely by the material that is readily available or the ease with which it is procured. A simple barricade can be erected by scraping or hauling dirt and piling it close to the magazine. A concrete or timbered wall can be erected at least 4 feet from the magazine, and the dirt may be piled against the wall; the width at the top of the pile or bank should not be less than 3 feet. An excavation made in the side of a hill for a magazine, with the excavated dirt built up in front, makes an efficient barrier. When the structures to be protected are on the same plane as the magazine, all sides should be barricaded essentially to or above the height of the magazine.

Foundations. Magazines should be so constructed as to prevent the stored explosives from absorbing dampness and to allow free circulation of air beneath the floor if it is a surface structure. Foundations should preferably be of brick, stone, concrete, hollow-tile or concrete blocks filled with concrete, or a combination of these. The height of the foundation above the ground at any point should be at least 1 foot. Foundations of magazines used for temporary storage may be wood posts, but the space between the ground and the floor should be enclosed and the enclosure covered with galvanized or sheet iron. In fact, the space under the floor of building-type magazines of any kind should be enclosed to prevent entrance of persons, animals, sparks, or firebrands. Screened vents should be left in the foundation walls for ventilation.

Ventilation. To be properly stored, explosives should be kept in a magazine which is dry and of uniform temperature; adequate ventilation is probably the best means of attaining such a condition. By means of vents in the foundation, walls and roof, air can be made to circulate freely in the magazine.

More consideration would be given to magazine ventilation if it were realized that the two primary causes for the deterioration of explosives are moisture and excessive fluctuation in temperature. Unless air circulates freely in the magazine, the atmosphere may become excessively hot, cold, or humid. Long exposure to such atmospheric conditions has essentially the same effect upon some explosives as dampness, with the result that there may be misfires or incomplete detonation or burning. With some types of explosives, unfavorable atmospheric conditions may cause the nitroglycerin to separate from the other ingredients causing nitroglycerin "leaks" which make the explosives more sensitive to shock or frictional impact.

Materials of Construction. The field representatives of the Bureau of Mines engaged in administering the Federal Explosives Act find magazines of various types and construction. Many of them are substantially built of concrete, stone, or hard-burnt brick; more frequently, however, magazines are built flimsily, as for instance, a light framework of wood covered with corrugated iron, with little or no attempt to make them bulletproof, theftproof, fireproof, or resistant to heat, cold or moisture.

Stone, concrete, or hard-brick magazines generally are thought to be undesirable because of the possibility of flying fragments in case of an explosion. The material used in the construction of a magazine should disintegrate and shatter easily if an explosion were to occur within the magazine, yet construction should be substantial enough to prevent theft.

The mandatory regulations relating to construction of surface explosives storage-magazines are given in the Federal Explosives Act.

In addition, those in charge of the administration of the Act offer the following recommendations:

Recommendations as to Surface Magazines

(1) Surface magazines should be well ventilated.
(2) Natural light or light by portable electric storage lamps or by protected electrical systems, or flood lights from the outside of the magazine should be provided.
(3) Floors should be made of wood or other nonsparking material and have no metal exposed.
(4) Magazines should be grounded if constructed of steel or covered with sheet iron.

Precautions Against Theft

Explosives must be protected against theft by storing them in magazines constructed and locked as required by regulations. Additional protection may be secured in appropriate cases by using:

(1) Mortise locks wherever practicable. When padlocks are used they should be protected by steel hoods or shields placed around the locks to prevent tampering. The hood or shield may be made from pipe or of steel large enough in diameter to enclose and protect the lock and hasp and at least 4 inches in length, securely fastened to the door by welding or by lugs that are riveted or bolted or fastened by some other secure method.
(2) Fences
(3) Floodlights
(4) Gas bombs
(5) Alarm systems, such as the "electric eye," etc.
(6) Additional guards or inspection by watchmen.

Precautions Against Fires

In order to prevent fires the following precautions should be taken:

(1) The magazine should be kept clean.
(2) Wastepaper, sawdust, used empty boxes and containers, and other combustible material should not be left to accumulate in or around any magazine.
(3) All surrounding area for 25 feet, and preferably 50 feet in all directions should be kept free of rubbish, dry grass, or other material of a combustible nature and where feasible the area should be covered with a material to prevent the growth of grass, weeds, and brush.
(4) Smoking, open lights, or other flame, or carrying of matches and smoker's articles into or around any magazine should be prohibited.
(5) Black powder and high explosives should be stored in separate magazines.

General Rules

The following rules, although not directly applicable to magazine construction, do apply to the safe operation of explosives and detonator magazines.

No detonators, tools, or other materials should be stored in a magazine containing explosives.

No high—or low—explosives or blasting device heaters should be stored in a detonator magazine.

Lighting in the magazine should be natural or by permissible lights; if a magazine is electrically lighted, the lamps should be of the vapor-proof type, the switch should be outside the building, and the wiring should be in conduit.

Only tools made of wood or other nonmetallic material should be used in opening cases of explosives.

Explosives should be so stored that the oldest stock is used first.

Cases of explosives should be stored top-side up; in other words, so that cartridges are lying flat.

However, they should be turned at regular intervals as this will help to prevent their deterioration.

Preferably, cases of explosives should not be piled in stacks more than 6 feet high.

Cases containing explosives should always be lifted and set down carefully; never slide one over on another or drop from one level to another or otherwise mishandle them.

Only authorized persons should be allowed in the magazine. One person should be made responsible for the operation and be held responsible and accountable for the contents of the magazine.

SAFETY WITH EXPLOSIVES

Safe use of explosives is the result of planning and doing the thing right. The user must remember that he is dealing with a powerful force, and that various devices and methods have been prepared to enable him to direct this force. He should realize that this force, if misdirected, may seriously and permanently injure him and his fellow-workers.

The following list of "Don'ts" has been prepared after many years of experience, and furnishes a comprehensive guide to safe practices. Nothing in this book is to be construed as superseding federal, state, corporation, or municipal laws, ordinances, or regulations.

DON'TS

Adopted by The Institute of Makers
of Explosives, May 8, 1951

For the purposes of this list of DON'TS, the terms contained therein shall be as follows:

The term "explosives" shall signify any or all of the following: dynamite, black blasting powder, pellet powder, blasting caps, and electric blasting caps.

The term "electric blasting cap" shall signify any or all of the following: instantaneous electric blasting caps, delay electric blasting caps, and delay electric igniters with blasting caps attached.

1. DON'T purchase, possess, store, transport, handle, or use explosives except in strict accordance with organizational, local, state, and federal regulations.

2. DON'T store explosives anywhere except in a magazine which is clean, dry, well-ventilated, properly located, substantially constructed, and securely locked.

3. DON'T allow persons under eighteen years of age to handle or use explosives, or to be present where explosives are being handled or used.

4. DON'T leave explosives lying around where children can get them.

5. DON'T allow leaves, grass, brush, or debris to accumulate within 25 feet of an explosives magazine.

6. DON'T smoke or have matches, open lights, or other fire or flame, in or near an explosives magazine, or have them nearby while handling or loading explosives.

7. DON'T shoot into explosives with any firearm, or allow shooting in the vicinity of an explosives magazine.

8. DON'T store any metallic tools or implements in an explosives magazine.

9. DON'T drop, throw, or slide packages of explosives or handle them roughly in any manner.

10. DON'T open kegs or cases of explosives in a magazine.

11. DON'T open kegs or wooden cases of explosives with metallic tools. Use a wooden wedge and wooden, rubber, or fiber mallet. Metallic slitters may be used for opening fiberboard cases, provided that the metallic slitter does not come in contact with the metallic fasteners of the case.

12. DON'T store or leave packages of explosives which have been opened without replacing the cover.

13. DON'T use empty explosives cases for kindling.

14. DON'T permit any paper product used in the packing of explosives to leave your possession. Accumulations of fiberboard cases, paper case liners, cartons, or cartridge paper should be destroyed by burning after

they have been carefully examined to make sure that they are empty.

15. DON'T use explosives that are obviously deteriorated.

16. DON'T attempt to reclaim or use fuse, blasting caps, electric blasting caps, or any other explosives that have been water-soaked, even if they have dried out. Consult the manufacturer.

17. DON'T carry explosives in pockets of clothing.

18. DON'T make up primers of explosives in a magazine or near excessive quantities of explosives.

19. DON'T force cartridges of any explosives into a bore hole or past any obstruction in a bore hole.

20. DON'T allow explosives, or drilled holes while being loaded with explosives, to be exposed to sparks from steam shovels, locomotives, or any other source.

21. DON'T spring a bore hole near another hole loaded with explosives.

22. DON'T load a sprung bore hole with another charge of explosives until it has cooled sufficiently.

23. DON'T tamp with metallic bars or tools. Use only a wooden stick with no exposed metal parts.

24. DON'T use combustible material for stemming.

25. DON'T allow near the danger area of a blast any persons not essential to the blasting operations.

26. DON'T fire a blast until all surplus explosives are in a safe place, all persons and vehicles are at a safe distance or under sufficient cover, and until adequate warning has been given.

27. DON'T return to the face until the smoke and fumes from the blast have been dissipated by adequate ventilation.

28. DON'T attempt to investigate a misfire too soon. Follow all applicable rules and regulations, or, if no rules are in effect, wait at least an hour.

29. DON'T drill, bore, or pick out a charge of explosives that has misfired. Misfires should be handled only by a competent and experienced man.

30. DON'T abandon any explosives. Dispose of or destroy them in strict accordance with the methods recommended by the manufacturer.

31. DON'T store cases of dynamite so that the cartridges stand on end.

32. DON'T leave dynamite, black blasting powder, or pellet powder in a field or any place where livestock can get at them.

33. DON'T take surplus quantities of permissible dynamite, black blasting powder or pellet powder into a mine at any one time. These explosives deteriorate rapidly in a damp atmosphere.

34. DON'T use black blasting powder or pellet powder with permissible explosives or dynamite, nor dynamite with permissible explosives, in the same bore hole in a coal mine.

35. DON'T tamp pellet powder in a bore hole hard enough to crush the pellets, because of danger of premature explosion.

36. DON'T store blasting caps or electric blasting caps in the same box, container, or magazine with other explosives.

37. DON'T leave blasting caps or electric blasting caps exposed to the direct rays of the sun.

38. DON'T insert a wire, a nail, or any other implement into the open end of a blasting cap to remove it from a box.

39. DON'T strike, tamper with, or attempt to remove or investigate the contents of a blasting cap or an electric blasting cap.

40. DON'T try to pull the wires out of an electric blasting cap.

41. DON'T connect blasting caps or electric blasting caps to Primacord except by methods recommended by the manufacturer.

42. DON'T attempt to fire a circuit of electric blasting caps except by

an adequate quantity of delivered current.

43. DON'T use in the same circuit electric blasting caps made by more than one manufacturer.

44. DON'T handle explosives during the approach or progress of an electrical storm. All persons should retire to a place of safety.

45. DON'T make electrical connections without first making sure that the ends of the wires are bright and clean.

46. DON'T allow electrical connections to come in contact with other connections, bare wire, rails, pipes, and ground, or other possible sources of current or paths of leakage.

47. DON'T leave electric wires or cables of any kind near electric blasting caps or bore holes charged with explosives except at the time of, and for the purpose of, firing the blast.

48. DON'T use electric blasting caps in very wet work unless they have adequate water-resistance and suitably insulated leg wires.

49. DON'T use any means other than a blasting galvanometer containing a silver chloride cell for testing electric blasting caps, singly or when connected in a circuit.

50. DON'T use damaged leading or connecting wire in blasting circuits.

51. DON'T use Duplex leading wire except for single shot firing.

52. DON'T tamper with or change the circuit of a blasting machine in any way for any purpose.

53. DON'T spare force or energy in operating a blasting machine.

54. DON'T store fuse or fuse lighters in a wet or damp place, or near oil, gasoline, kerosene, distillates, or similar solvents.

55. DON'T store fuse near radiators, steam pipes, boilers, or stoves.

56. DON'T handle fuse carelessly in cold weather. If possible, it should be warmed slightly before using to avoid cracking the waterproof coat.

57. DON'T use short fuse. Cut fuse long enough to extend beyond the collar of the hole and to allow time to retire safely from the blast. Never use less than 2 feet.

58. DON'T cut fuse until you are ready to insert it into a blasting cap. Cut off an inch or two to insure a dry end.

59. DON'T cut fuse on a slant. Cut it square across with a clean, sharp blade. Seat the fuse lightly against the cap charge and avoid twisting after it is in place.

60. DON'T crimp blasting caps to fuse with a knife or with the teeth. Use a standard cap crimper and make sure that the cap is securely fastened to the fuse.

61. DON'T use fuse and blasting caps in wet work without having a thoroughly waterproof joint between the fuse and cap.

62. DON'T kink fuse in making up primers or in tamping a charge.

63. DON'T hold the primer cartridge in the hand when lighting fuse.

64. DON'T light fuse in any bore hole until the holes contain sufficient stemming to protect explosives from sparks from the end spit of fuse or a flying match head.

65. DON'T try to light fuse with burning paper, other flammable refuse, or improvised torches.

66. DON'T light fuse near blasting caps or any explosives, other than those being used in the blast.

Destruction of Explosives*

Explosives to be destroyed may be fresh material from damaged packages, or material that has deteriorated either from natural aging or from improper storage to the point where it is unfit for use.

Deteriorated explosives may be, and often are, more dangerous to handle than explosives in good condition. When there is any question about the safety of the undertaking, a representative of the manufacturer of the particular lot of explosives should be consulted or a request for assistance made to an authorized representative of the Bureau of Mines, or to some one else known to have had the necessary experience. This is especially true if large quantities of explosives must be destroyed.

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* U.S. Bureau of Mines Circular 7335

Most explosives, except detonators, are best destroyed by burning. The hazard of an explosion is always present, even under the most favorable conditions, so it is of prime importance to select a site where no damage will be done, either to persons or property, if the explosives detonate. This means a safe distance from any structure, railroad, or highway and from any place where one or more persons may be even accidentally exposed to danger, including that from flying fragments.

During the destruction of any type of explosives the possibility of preignition should be prevented by eliminating smoking and open lights.

Only one type of explosive should be destroyed at a time, and the utmost care should be taken to see that no detonators are accidentally included in explosives to be destroyed by burning.

High explosives should never be burned in cases or in deep piles. Dynamites, especially permissible gelatins, become increasingly sensitive when overheated before ignition. Quantities of dynamite to be burned should not exceed 100 lbs of regular dynamite or 10 lbs of permissible gelatin. Local conditions may limit destruction to much smaller amounts, but when more than these maximum quantities must be destroyed, a new space should be selected for each lot, as it is not safe to place explosives on ground heated by the preceding burning.

No attempt should be made to return to the site as long as any flame or smoke can be observed.

As soon as all dynamite has been burned, it is believed to be good practice to plow the ground, as the residue remaining may contain salts said to be attractive to livestock, which if eaten may produce serious results.

Dynamite. When properly stored, dynamite should remain in good condition for a long time, but it may, and usually does deteriorate rapidly if improperly stored or handled. The most common signs of deterioration are discoloration, leakiness, hardness or excessive softness, or the formation of crystals on the outside of the wrapper. Frequently a combination of two or more of these signs can be noted.

Many persons believe that the crystals are nitroglycerin and that they are especially dangerous; while these are not facts, because the crystals actually are salts that have exuded through the wrapper, whereas nitroglycerin is an oily liquid at normal temperatures, their presence on the outside of the wrapper or on the container shows that the dynamite has deteriorated to some degree.

Care should be exercised in handling deteriorated explosives, whether loose or in containers. Most persons experience undesirable effects, especially headaches of varying degrees of severity, by absorption of nitroglycerin through the skin when handling leaky or loose dynamite, and some persons are so sensitive as to have headaches after working over loose dynamite for only a short time, even without touching it. Therefore, if leaky or loose dynamite must be handled, gloves should be worn and then burned as often as they become impregnated with nitroglycerin.

Some dynamites are rather difficult to ignite, especially when wet, so it is best to prepare a bed of dry, combustible material, such as excelsior, wood shavings, or sawdust; to maintain combustion it is sometimes necessary before igniting the pile or bed to pour a little kerosene over the dynamite and the fuel bed. The area of the bed should be such that the dynamite can be arranged in a single layer if sticks or part sticks are being destroyed, or arranged not to exceed 2 inches in thickness if loose dynamite is to be burned. The bed should be long and narrow rather than square or circular.

It is often recommended to slit each stick of dynamite and scatter the loose material on the fuel bed;

but, considering the extra hazard to the operator it seems preferable to deposit whole sticks of the more common sizes on the fuel bed as carefully as possible without slitting. If the cartridges are of large diameter, such as those often used in quarry blasting, the loose material should be spread; "free running" (loose) dynamite may be so spread, but never in a thickness exceeding 2 inches.

When the bed has been formed and the dynamite deposited on it, a train of paper or similar readily ignitable material should be laid to it, preferably on the down-wind side, and the explosives ignited thus. The train should be long enough to permit the operator to reach a safe place.

Dynamite should ordinarily burn quietly, with a bluish flame. If solid pieces remain, as sometimes happens, especially if the dynamite is wet, it is dangerous to poke about the debris or attempt to handle the pieces for reburning until it is certain that they are cool. The containers should be burned separately.

Detonators. Blasting caps, electric blasting caps and delay electric blasting caps that have so deteriorated from age or improper storage that they are unfit for use should be destroyed. These devices should also be destroyed if they have ever been under water as, for example, during a flood, regardless of whether or not they have been subsequently dried out. In some cases, the shells of caps that have been wet and then dried will show signs of corrosion. Such caps may be very dangerous to handle, and it is recommended that they not be disturbed until a representative of the manufacturer has had an opportunity to pass on them. The method most generally used for destroying detonators is to explode them under some confinement as described below. *Detonators should not be thrown into small bodies of water* such as rivers, creeks, ponds, or wells.

If possible, it is advisable to explode ordinary (fuse) blasting caps in the original container with the cover removed. Otherwise, they should be prepared for blasting as follows: They should be placed in a small box or bag; a hole should be dug in the ground, preferably in dry sand, at least 1 foot deep; the container should be placed in the bottom of the hole and primed with one cartridge of dynamite and a good electric blasting cap or ordinary cap and fuse; the caps and the primed cartridge should be carefully covered with paper and then with dry sand or fine dirt and fired from a safe distance. It is recommended that not more than 100 caps be destroyed at a time and that the ground around the shots be thoroughly examined after the shot to make certain that no unexploded caps remain. The same hole should not be used for successive shots.

To destroy electric blasting caps or delay electric blasting caps, it is necessary first to cut the wires off about 1 inch from the top of the cap, preferably with a pair of tin snips. No attempt should be made to cut the wires from more than one cap at a time. Not more than 100 caps should be placed in a box or paper bag, primed with a cartridge of dynamite and a good electric blasting cap, buried under paper and sand or dirt, and exploded as described above. The same precautions mentioned above should be observed.

Blasting caps should never be destroyed by placing them in a hole which is to be shot, especially by dropping them into well-drill holes. Many bad accidents have occurred in this way.

Electric Squibs and Delay Electric Squibs. These devices should be destroyed by the same procedure as used for electric blasting caps.

Safety Fuse. This material may be disposed of very satisfactorily by burning in a bonfire.

Primacord. The preferred method of destroying Primacord is by burning. It should not be burned on the spool but should be strung out in parallel lines one-half inch or more apart on paper or dry straw.

Removal of Nitroglycerin from Magazine Floors. Contaminated floors should be scrubbed well with a stiff broom, hard brush or mop, using an ample volume of a solution in the proportion of 1½ quarts of water, 3½ quarts of denatured alcohol, 1 quart of acetone, and 1 pound of sodium sulfide (60 per cent commercial). The liquid should be used freely to decompose the nitroglycerin thoroughly. If the magazine floor is covered with "Ruberoid" or any material impervious to nitroglycerin, this portion of the floor should be swept thoroughly with dry sawdust and the sweepings taken to a safe distance from the magazine and destroyed by burning.

It was formerly considered good practice to cover explosives-magazine floors with rubber or similar material, but the best practice now is generally believed to be a tight, smooth floor, free from exposed nails or other metal fastenings, so as to eliminate holes and ragged edges that sooner or later result from excessive wear. Floor coverings often hide floor stains and, when worn, render proper cleaning difficult or impossible unless the whole covering is removed. With the tight wood floor now considered best, cleaning is more certain and, if necessary, parts of the floor can be carefully removed and replaced.

Conclusion

Manufacturers frequently employ other methods of destroying explosives and blasting supplies than those described above, but when employed these should be used only under direction of the manufacturer's representative.

As indicated previously, the information given here is not for the purpose of encouraging persons unfamiliar with the proper methods of destroying explosives to undertake such work unassisted. It is realized however that expert advice and assistance are not always available and it is believed that destruction of unwanted explosives can be accomplished with less hazard by following the foregoing suggestions. See also Explosives; Explosives, High; Explosives, Low in Section 10 and Section 6.

Appendix 2

TANKS FOR STORAGE OF FLAMMABLE LIQUIDS

The contents of storage tanks have played a part in some very serious fires. There are three types of tank storage (a) underground; (b) above ground, outside building; (c) above ground, inside building.

Underground Tanks

Plans for underground storage tanks designed for flammable liquids should be discussed with local building groups, national regulatory groups, and an insurance carrier. The following is a check list of items to be considered:

(a) The optimum size and position of the buried tank; that is, whether it shall be vertical or horizontal.

(b) Location of the tank with respect to the terrain in the general area which is to be considered, the location of buildings, cellars, pits, etc. in the same area. Also the possibility of corrosion is an important factor.

(c) Adequate anchorage for the tank, keeping in mind the possibility of flood, heavy rainfall, or other events and what effect these might have on the installation.

(d) Sufficient covering for the tank; this will improve the safety of the installation and help with the problem of anchorage.

(e) In selecting a location in which to bury a tank, cognizance must be taken of the possibilities for corrosion, to prolong the life of the tank. It is important to determine if the region chosen is reasonably free of corrosive effluents from nearby plants, corrosive cinder-fill, or possibly corrosive ground water. If corrosion is considered likely, tanks should be painted with at least one coat of red lead in linseed oil primer and then one coat of asphalt or coal-tar base paint. Other formulas may be equally effective.

(f) It must be remembered that the equivalence of a below ground location may be obtained with a partially buried tank. In such a situation the exposed part of the tank may be covered with a dirt fill and a concrete cap as well as a concrete retaining wall for anchorage.

Above Ground Tanks

Above ground tanks can be a source of extreme danger, if not planned carefully. For instance, rupture of an above ground tank or a leak in such a tank at a point below the liquid level may very easily lead to a serious fire. Therefore, such tanks should be located on ground sloping away from main buildings and plant utility installations. Protection against fire spread is provided on level ground by tank spacing, proper drainage facilities and adequate dikes. In hilly terrain provision must be made for safe drainage past installations at lower levels. The following considerations must be kept in mind when planning a flammable-liquid storage tank above ground:

(a) The possibility of damage to nearby buildings or tanks.

(b) The amount of flammable material contained in the unit under consideration.

(c) The values involved in the unit under consideration and those adjoining.

(d) The burning and ignition characteristics of the materials involved.

(e) The provision of adequate room for fire-fighting operations and access for fire-fighting equipment.

(f) Dike capacity of such an installation: In the ideal case the dike capacity should equal the total tank capacity inside the dike area. Where the flammable liquid involved is such as may be subject to boilover, i.e. fuel oil, etc., the diking capacity must be 1.5 times the total liquid capacity of the tanks in the dike area.

(g) Adequate drainage arrangements must be made to prevent the accumulation of water in dike areas.

Tank Construction

The following points must be considered in making sure that tank construction is adequate:

(a) In the case of horizontal steel tanks, it should have an Underwriters' label indicating that it meets definite construction standards.

(b) All horizontal tanks must be given a hydrostatic strength and leakage test before installation is complete.

(c) In the case of above ground tanks, they must be constructed upon fire-resisting supports such as brick or reinforced concrete.

(d) Vertical steel tanks must be constructed in accordance with the American Petroleum Institute's specification for standard tanks.

(e) A leakage test is recommended for vertical tanks.

(f) Provision must be made for adequate venting facilities and flame arrestors.

Tank Connections and Fittings

(a) Connections to horizontal tanks

(b) The use of steel flanges or wrought iron couplings to make pipe connections

(c) Provision for man-holes

(d) Provision for shut-off valves

(e) The use of heating equipment

(f) The use of electrical equipment with the attendant necessities for prevention of sparks, i.e. grounding, electrical bonding, etc.

Fire Protection

The protection required for tanks containing flammable liquids is determined by the tank size, type, location, exposure to or from buildings or other tanks, value of contents, flash point of the liquid stored, and the probability of the interruption to production by loss of tank contents.

Conditioning and Use of Old Tanks

Failure to take proper precautions during the cleaning and repair of used tanks can result in serious explosion hazards. To avoid such hazards the following precautions should be observed.

(a) Tanks which have contained flammable liquids should be purged with steam or filled with water and allowed to drain, or combinations of these methods may be employed.

(b) Use a portable flammable vapor indicator to determine that vapor concentrations inside such tanks have been reduced to safe levels.

(c) Remove all remaining scale and sludge from inside such tanks with non-ferrous scrapers. The use of detergents to clean such tanks, while helpful in actually removing the residues, should be undertaken with care, because for example, caustic solutions promote the decomposition of nitrocellulose residues, and the reaction thus started will move with explosive violence under the proper conditions.

(d) Take the additional precaution of filling the tank with water or an inert gas such as carbon dioxide, if cutting or welding torches must be used on it.

(e) Proper supervision of the workers and sufficient ventilation is essential inside a tank.

(f) While such reconditioning or repair is in progress, it is wise to move any readily flammable materials from the neighborhood.

Appendix 3

INDUSTRIAL DISASTER CONTROL

The function of disaster control in industry is taking on increased importance. Such factors as industrial plant decentralization and the advent of newer and more powerful weapons of war have made it necessary for a plant to be as self-sufficient as possible, particularly during times of emergency. All that disaster planning involves is an extension of routine fire and emergency programs to cope with disaster.

The first requirement of a disaster control program is common sense. No highly specialized knowledge or backlog of experience is necessary. The essence of disaster planning is thorough analysis of the existing plant facilities, with emphasis on emergency facilities, and observance of how they may be affected by a disaster. Unless a plant is in the zone of total destruction of an atom bomb, or some similar destructive agency, an adequate disaster control plan is important. Although it is possible to protect against an atomic detonation, the protection necessary is so elaborate and so costly that it may not be economically feasible.

Model Disaster Control Program

Make a complete survey of existing functions and facilities, including possible emergency facilities. It is necessary to determine what is done under routine conditions and what is to be done when these conditions are disrupted, e.g., during the emergencies created by fires, hurricanes, earthquakes, release of toxic materials, bombs, etc.

Determine the key production points in the plant—the departments and processes which, if interrupted, would result in a complete production stoppage. Such key locations should have the best possible protection. A plan, to be successful, must be sufficiently broad in scope to be adaptable to any emergency. Specific operational details, of course, need not be included, since these will depend upon the actual nature of the emergency. The following factors, however, must be taken into consideration: executive authority and duties; handling the alarm; emergency headquarters; operations of the police force; operations of maintenance force; operations of fire department; operations of medical department; operation of public information and industrial relations group; operation of monitoring group for toxic inhalants and radioactivity.

Executive Authority and Duties

A person responsible for coordinating the operation of all emergency groups must be designated in advance to serve as plant emergency director. Provision must be made for succession of command. There must be no confusion as to who is in charge. The plant manager is usually a good choice during office hours, and the general shift foreman for nights and holidays. It is recognized that someone with authority must be available during emergencies.

The plant emergency director shall coordinate the efforts of the emergency groups which shall include: determination of seriousness of emergency condition; sounding general alarm throughout plant; directing operation of all plant forces from emergency headquarters; promptly summoning any outside aid which may be deemed necessary. (In calling outside assistance, the plant emergency director may secure excellent advice from the heads of his own forces, e.g., the plant fire chief might be consulted on the necessity of summoning outside fire assistance.) Aid of various types should be promptly summoned. If necessary, it can be turned back if not needed upon arrival. Delay can be disastrous; inform the press as to requirements of public interest in an attempt to avoid promoting misinformation;

attempt to maintain a log of events to serve as a record.

Handling the Alarm

Upon discovering an emergency, the individual employee shall:

For a fire or explosion, pull nearest fire alarm box, or telephone fire department. (The importance of indoctrinating all personnel in advance as to how to transmit a fire alarm *cannot be overemphasized.)*

For other emergencies, telephone for ambulance, police patrol, emergency repair, medical, safety or decontamination aid as may be necessary.

For notification, the plant emergency director should be notified immediately after completing the call for assistance. The supervisor shall, immediately upon learning of an emergency in his area, proceed to the scene and see that the appropriate notifications as required above have been made. He will direct the forces at hand in initiating appropriate action and then report to the plant emergency director. An emergency procedure should be established for the telephone switchboard operators to screen telephone calls, restricting the use of lines to official calls.

When an emergency is reported, a general alarm should be sounded alerting the entire plant; the method of sounding the alarm depends on the equipment available at the plant. In such an eventuality, all personnel except those initiating on-the-spot-action or assigned to some specific function, should evacuate their respective buildings, closing all doors but not locking them, and assemble in front of their buildings to await further orders. All radioactive, highly toxic or corrosive materials should be locked up.

Emergency Headquarters

Primary and secondary emergency plant headquarters from which operations will be directed should be established in advance. The communications room in the police or guard headquarters is usually a good location for the primary headquarters. A secondary headquarters is necessary in the event that the primary location is involved in a disaster; if both the primary and secondary locations are knocked out, an alternate will have to be set up on the spot by the executive authority. Depending upon the plant, the secondary or alternate headquarters might be established at the fire headquarters, plant management office, safety director's office, etc., or in the field. A portable sign reading "Emergency Headquarters" should be provided at the appropriate location. (Red lettering on a white background is recommended.) Red electric lanterns should be used at night in emergencies to designate the headquarters. Both primary and secondary headquarters should be equipped with: telephone facilities, both interplant and outside; radio (if available); map showing fire mains, fire alarm boxes, fire hydrants, general piping layouts and similar pertinent data; telephone numbers (plant and home) and home addresses of key personnel, together with information as to the time and route required for each person to report to the plant in response to an emergency call; same information as above for all other personnel; specific information as to how to contact and/or obtain the following services: fire department; police department; medical services; ambulances; public utilities; other public services, and means of contacting nearby military establishments if assistance is needed, e.g., air transportation.

Operation of Police Force

The chief of the police force is responsible for maintaining the material and data required at primary and secondary emergency headquarters. In case of emergency, the Senior Police Officer on the premises shall: maintain liaison with the plant emergency director; alert guards on duty; maintain order at all scenes of emergency; assist plant emergency director in placing calls for outside assistance and for recalling off-duty personnel; escort emergency vehicles and personnel returning to the plant to appropriate locations; if equipped with radio, dispatch radio patrol cars to locations determined by the plant emergency director in order to maintain communications, particularly in the event of telephone failure (if both telephone and radio fail, police will have to handle communications within plant and with outside agencies by messenger); stand by to evacuate entire plant if necessary; if the emergency requires outside personnel, the police should guide them to the emergency headquarters where the director will direct their admittance and disposition.

Operation of Maintenance Staff

The maintenance staff initiates emergency action if large-scale plant emergency groups are not maintained, e.g., in the event a plant does not have a full-time fire department, the maintenance personnel organized and trained as a fire brigade should immediately combat a fire and attempt to prevent it from spreading pending arrival of the outside fire department.

Maintenance personnel should be organized by the chief of maintenance into appropriate squads to handle electrical repairs, emergency lighting, rescue, maintenance of power and water supply, salvage operations to minimize water damage, transportation, etc. The senior maintenance man should maintain liaison with the plant emergency director and direct the operations of his various divisions. Maintenance personnel should be kept informed of hazardous materials in the plant and how to cope with them.

Operation of Fire Department

The cooperation between the plant and municipal fire departments should be outlined in detail on a mutual aid agreement plan. Regardless of how an alarm is received, the fire department immediately responds in accordance with prearranged plan. Upon arrival at the scene, the senior fire officer present is in charge of all fire department apparatus and personnel. He maintains liaison with the plant emergency director and with the monitors as concerns radiological and toxic chemicals safety.

An extra supply of rubber boots, clothing, helmets and fire hose is desirable where regular equipment may become contaminated.

Fire department personnel should be kept informed of all hazardous materials in a plant and on how to cope with same.

Operation of Medical Department

The chief of the medical department shall be responsible for first aid training and for the procurement, maintenance and availability of appropriate medical supplies.

The senior medical man present at the time of an emergency shall: maintain liaison with plant emergency director; care for injured; transport casualties to municipal hospitals as may be necessary; arrange for appropriate ambulances and for other vehicles to serve as ambulances in cases of catastrophe; when casualties are sent to outside hospitals, maintain liaison with the hospital personnel as to the nature of injuries and whether or not radioactivity is a factor; coordinate efforts of Red Cross units which may be called in.

Depending upon the outside hospital facilities available, the chief of the medical department may want to have mimeographed copies of medical data available relative to contamination control for distribution to municipal hospital medical personnel in times of emergencies. Immediately after a disaster the medical division, in cooperation with industrial hygiene personnel, shall evaluate the degree of severity of exposures. Special clinical and laboratory examinations of blood and urine should then be performed on all individuals who may have received significant exposure. Follow-up examinations will have to be made at the discretion of the medical department.

Operation of Public Information and Industrial Relations Group

Public information releases should generally be prepared by the plant emergency director or some other authoritative individual designated in advance. It is recommended that these be in writing, if time permits, to prevent misinterpretation. A list of editors and radio newsmen should be prepared well in advance, so that these individuals can be contacted as quickly as possible and informed that a written release statement is being prepared with authoritative information relative to the emergency.

The senior industrial relations representative, safety director and senior insurance department representative shall maintain liaison with the plant emergency director. The insurance representative shall, in addition: obtain names, addresses and severity of injury to all casualties; when ordered by plant emergency director, notify the families of the casualties as to the nature of injury and location of injured; prepare necessary reports for insurance carrier.

Operations of Monitoring Group for Toxic Inhalants and Radioactivity

When an emergency occurs this group shall assemble at its base and immediately contact the plant emergency director, who shall instruct the monitoring group leader as to the areas to be monitored and the contaminants or radiations to be measured. While maintaining constant contact with the plant emergency director both for direction and to report monitoring results, this group has the following responsibilities:

In accordance with a prearranged plan to have personnel evacuated from contaminated or high radiation level areas; to assist in the control of exposures to radiation and toxic materials by firemen or other emergency workers; to monitor possible contaminated personnel in order to control the spreading of contamination as well as to be able to advise personal decontamination procedures; to help in decontamination of any contaminated areas; to make checks upon possible environmental contamination, e.g., fall-out, radiation, contamination of water, air or food, livestock, houses, etc. *Since hastily given numbers are often misunderstood, it is a prime responsibility of a monitor to see to it that his data go only to the plant emergency director to use as he sees fit.*

While the foregoing discussion does not provide a complete plan for controlling plant disasters, it is hoped that it will serve as a guide and provide stimulus for thought and planning relative to continuity of production and safe-guarding of personnel during actual emergencies.

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SECTION 8

REACTOR SAFEGUARDS

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Table 1. Estimated World Reserves

	Estimated Reserve	Q Units	Estimated Duration of Reserves in Years
Coal	3×10^{12} metric tons (4)	86	$89.8Q = 3.2\,(e^{0.025t} - 1)$
Oil	10^{12} barrels (4)	3.8	Duration $t = 134$ years

Table 2. Estimated United States Reserves

	Estimated Reserve	Q Units	Estimated Duration of Reserves in Years
Coal	1.38×10^{12} tons (4)	36	$37.84Q = 1.6\,(e^{0.025t} - 1)$
Oil	250×10^{9} barrels (2)	1	Duration $t = 128$ years
Natural Gas	600×10^{12} cu. ft. (2)	0.84	

It has been stated that oil production will begin to decline in the United States in 10 to 15 years (2), and the rest of the world not long afterwards. Natural gas production will probably begin to decline by 1970. In the eastern part of the United States, Ayres (2) indicates that bituminous coal beds will be so depleted by 1970 that the cost of coal would be significantly increased or new ways of using poorer quality coal would have to be found. The extraction of oil from oil shale and tar sands may ultimately be called upon to extend our fossil fuel supply a few years.

Present estimates place the world's total commercially significant uranium and thorium resources at 8 million (5), or 655 Q units; assuming that all fuel is converted to fissionable material through breeding.

Another clue to the urgency of the world's need for atomic energy is that although the total world expenditure of energy during the years 0 to 1950 A. D. was less than 13 Q units, it is estimated that 20 Q units will be used in the 50 years from 1950 to 2000 A. D. During the 100-year period from 2000 A. D. to 2100 A. D. the energy requirements will be 100 Q units. Therefore, it is clear that nuclear energy or some other source of large quantities of energy will be necessary to fulfill future requirements, even in fact if estimates of available energy sources are high by as much as one order of magnitude.

Utility and Economy of Nuclear Energy

The utility of nuclear power is today more clearly evident to the population as a whole than was the utility of the airplane during the equivalent stage in its development. For example, it is realized that a nuclear powered submarine has the advantage of possible prolonged operation under water since a nuclear reactor for the production of power does not require oxygen for its operation as does a diesel engine. In addition, the possible speed and endurance made possible by nuclear propulsion is significantly greater than that possible under conventional methods of propulsion. Similarly, a nuclear powered airplane could probably make a nonstop flight around the earth at the equator without refueling. There are furthermore many military advantages to the use of nuclear power that make it attractive to use at any price. Finally, nuclear reactor produced power would even at the present stage of development be very useful in areas where the cost of transporting fuel is high. Since 1 gram of fissionable fuel will release approximately the same quantity of heat or power as 1 ton of coal, transportation of nuclear fuel per unit of energy produced is much easier.

The utility of and market for nuclear reactors are further demonstrated by the following classification of reactors.

Classification of Nuclear Reactors

- A. Legal Classification
    - 1. Production facility
    - 2. Utilization facility
- B. Hazard Classification
    - 1. Critical (Zero Power Reactor) assembly
    - 2. Power reactor
- C. General Classification
    - 1. Single purpose reactor
    - 2. Dual purpose reactor
- D. Practical Classification
    - 1. Power reactor
        - (a) For central power stations
        - (b) To locomote submarines, airplanes, ships, trains, etc.
        - (c) To provide package reactors for remote locations
    - 2. Breeder reactors
        - (a) Dual purpose reactor
        - (b) Single purpose fuel breeder reactor
    - 3. Medical reactor
        - (a) Isotope producer
        - (b) Medical therapy reactor
    - 4. Research and development
        - (a) Material test reactor
        - (b) Preliminary test reactor
        - (c) Educational reactor

The AEC has the responsibility under the Atomic Energy Act of 1954 of licensing installations using nuclear fuel. The Commission has classified all reactors as production facilities or utilization facilities where a production facility (6) is any reactor designed or used primarily to produce fissionable material (Pu-239, U-233); to separate uranium or plutonium isotopes (except facilities designed and used for research, development or analytical purposes only); for the chemical, physical or metallurgical processing of special nuclear materials (except facilities designed and used for research, development or analytical purposes). A utilization facility is any nuclear reactor other than one designed or used primarily to produce Pu-239 or U-233. For the purpose of hazard evaluations reactors may be classified as either critical assemblies (if the operational period is short and the power level low) or, if the reactor operates for extended periods in the megawatt range, it is considered a power reactor. A single purpose reactor is a reactor that is operated for the purpose of producing power alone or for the single purpose of producing fissionable material such as Pu-239. A dual purpose reactor is one which is designed to produce both power and fissionable material. Under the practical classification, the utility of nuclear power for medical therapy, industrial research, and/or educational purposes is evident.

Domestic and foreign industrial power requirements plus military requirements for atomic energy will in the future provide the largest markets (7) for nuclear reactors. It has been predicted (8) that by the year 1980, 65% of all new generating installations in this country will be nuclear.

As to the costs, the construction and operation costs of a nuclear reactor plant have been frequently estimated (9) and then compared with the cost of construction and operation of a conventional power plant. These estimates vary with the location, the design and the operating power of the reactor in addition to the use to which the reactor will be put. There has been some disagreement as to the estimated cost of nuclear power. This disagreement has resulted because of the variety of unknown economic factors associated with nuclear power operations. To illustrate, the unit cost may be significantly different when calculated for a single purpose reactor than for a dual purpose one. Also such factors as the selling price of the nuclear fuel produced in the reactor together with the cost of insurance and radioactive waste disposal are very difficult to estimate at this time. In fact, several years ago the cost of nuclear power was estimated to be at least twice the cost of coal-produced power, but relatively up-to-date detailed cost comparisons (10) of a boiling water reactor, a graphite reactor and a coal fired plant at a power level of 300 Mw find the reactors to be competitive. The actual estimated costs of power were 6.7, 6.8, and 6.9 mills/kw-hr, respectively. All estimators, significantly, agree that costwise nuclear power will someday be competitive with conventional power, particularly with improvements in reactor design, increased burn-up of fuel and reduction in cost of separation processes; they simply disagree as to when this will be.

Some of the unusual expenses associated with the construction and operation of nuclear power plants are listed below.

Unusual Expenses Associated With Nuclear Power Plants

- Construction Costs for:
  - Containment building
  - Radiation shielding
  - Safety mechanisms
  - Exclusion area
- Operation Costs for:
  - Reprocessing of fuel
  - Power losses from locating at a distance from populated areas
  - Insurance
  - Decontamination
  - Waste disposal

General Sources of Reactor Failures

Although nuclear reactors can at the present time not be considered as inherently safe, the probability of a serious incident resulting from the operation of a reactor in accordance with present day federal and state regulations is very small. Nuclear incidents (11) which do occur may be the result of an improperly designed reactor, gross equipment failure, human error and sabotage.

Responsibility for Reactor Safety

The United States Atomic Energy Commission has promulgated a regulation (12) concerning reactor safety which is applicable to AEC-owned reactors. Reactors subject to license by the AEC but not owned by the AEC are left for future regulations.

In general, this regulation provides for a system of reporting of safety considerations in connection with reactor construction, modification and operation. It also establishes a procedure for the evaluation of reactor hazards on the basis of such reporting and other available data. With regard to "responsibility" the regulation states, "Managers of Operations in developing and administering safety programs within their jurisdiction have a responsibility for the safe operations of reactors and for carrying out the requirements of this instruction." This regulation is completely reproduced in this section.

The Commission has under consideration a proposed regulation (13) for the establishment of standards for employee and public protection against radiation hazards arising out of activities under licenses issued by the AEC pursuant to the Atomic Energy Act of 1954.

In addition to the federal government, the state governments also may have a regulatory function in connection with the use and possession of special nuclear materials. Both the Department of Health and the Department of Labor in the State of New York for instance have formulated codes for protection of employees and the public against radiation. Many other states are in the process of officially adopting or drafting codes on radiation protection. In addition to the state codes, and the AEC Regulations on radiation protection, the National Committee on Radiation Protection has appointed a Committee to draft a model state law on radiation protection for use by governmental agencies.

Considerable effort is being expended at all AEC sites to improve the safety of nuclear reactor operations. It is customary at many sites to form a Safeguard Task Force whose responsibility it is to consider all methods of improving the safe operation of reactors; (1) by improving the design of the nuclear plant and the power plant building; (2) by reducing the incidence of gross equipment failure; (3) by reducing the possibility of human error through the insertion of automatic control and the concept of inherent safety whenever possible in nuclear reactor operations; and (4) by making sabotage practically impossible. Such a Task Force may also draft the required report of the nuclear hazards associated with a particular reactor operation for transmittal to the Advisory Committee on Reactor Safeguards of the General Manager of the AEC.

Many of the AEC sites have their own advisory committees on reactor safeguards which review all the safeguard problems at the site and make recommendations for action to the General Manager of the site.

With all of these committees and task forces striving to make reactors inherently safe, there is little doubt of the future of nuclear reactors from a safety viewpoint. The health records of personnel working at AEC installations are very good and indications of the excellent control over radioactive hazards exercised by these organizations.

AEC Regulations on Reactor Safety Determination (12)

Purpose and Scope

This Instruction provides a guide for the processing of reactor safety determinations involving AEC-owned reactors within the AEC. It has no application to reactor hazard matters pertaining to reactors subject to license, which will be covered by separate regulations published in the Code of Federal Regulations. Specifically, it establishes:

a. AEC policy on evaluating safety aspects of proposed new AEC reactors or significant modifications of existing reactors.
b. Role of the Reactor Hazards Evaluation Staff, the Advisory Committee on Reactor Safeguards and other offices.
c. Responsibility for evaluating reactor hazards, and for developing reactor standards, guides and codes.
d. Procedure for obtaining a review of reactor hazards evaluations and information by the Advisory Committee on Reactor Safeguards.

Policy

In order to protect the health and safety of the public, AEC property and employees, and employees of AEC contractors, it is the policy of the AEC to evaluate hazards of existing reactors as well as with each proposal to build a new AEC reactor or to significantly modify an existing AEC reactor against established safety standards, guides and codes.

Responsibilities

The Reactor Hazards Evaluation Staff, serving in a staff capacity:

a. Develops standards, guides, and codes considered necessary to the public health and safety for the design, operation, supervision, containment, and location of reactors.
b. Evaluates all proposals for new reactors and significant modifications in existing reactors by reviewing all pertinent reactor hazard information on the basis of established standards, guides, and codes.
c. Provides staff advice and assistance as required to the Advisory Committee on Reactor Safeguards. (The Chief, Reactor Hazards Evaluation Staff, serves as the AEC staff associate of the Advisory Committee on Reactor Safeguards as required by GM-O and M-22 to be published as Chapter 0105.)
d. Supplies secretarial and administrative assistance to the Advisory Committee on Reactor Safeguards as required.
e. Participates jointly with the Division of Inspection in developing a comprehensive plan for conducting investigations as to the cause of major reactor accidents.

Directors of Operating Divisions Shall:

a. Assure the AEC that Operations Offices under their jurisdiction apply the AEC reactor safety standards, guides and codes.
b. Review AEC Reactor Hazards Summary Reports for completeness and obtain additional information, where necessary, prior to transmittal of subject reports to the Reactor Hazards Evaluation Staff.

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*The Advisory Committee on Reactor Safeguards serves in an advisory capacity to the General Manager of the AEC, with regard to hazards associated with the construction and operation of AEC-owned reactor facilities.

Managers of Operations in developing and administering safety programs within their jurisdictions have a responsibility for the safe operations of reactors and for carrying out the requirements of this instruction. Specifically, they shall:

- a. Apply the AEC reactor safety standards, guides, and codes to reactor facilities under jurisdiction.
- b. Conduct inspections of AEC owned reactors under their jurisdiction.
- c. Obtain Hazards Summary Reports from contractors as required, and forward such reports to the Headquarters Operating Division evaluation.

The Director, Division of Inspection

- a. Appraises reactor safety inspection programs of the Operating Division and Operations Offices.
- b. Conducts investigations of reactor accidents and occasional independent inspections of reactors if deemed advisable by the General Manager.

The Hazards Summary Report

The Hazards Summary Report shall contain the following:

- a. A description of the chemical, physical, metallurgical, or nuclear process to be performed, and a statement of the kind and quantity of any radioactive effluent expected to result from the process. The description of the process shall be sufficiently detailed to permit evaluation of the radioactive hazards involved. The magnitude of the proposed operation shall be indicated in terms of the amount and radioactivity of source, special nuclear, or by-product material to be handled per unit of time, and thermal power to be generated, if any.
- b. A description of the facility based on the design criteria for the facility as a whole and for those major component parts which are essential to the safe operation of the facility, and shall be presented in sufficient detail to allow an evaluation of the adequacy of the various means proposed to minimize the probability of danger from radioactivity to persons both on- and off-site. The description shall also cover any activities, other than those subject to license, proposed to be carried on in the building which will house the facility and on the balance of the site.
- c. A description of the site on which the facility is to be located which shall include a map of the area showing the location of the site and indicating the use to which the surrounding land is put i.e., industrial, commercial, agricultural, residential, and a scale plot plan of the site showing the proposed location of the facility.
- d. A general description of proposed procedures for: routine and non-routine operations, start-up and shut-down, maintenance, storage, training of employees, minimizing operational mishaps such as locked controls, preparation of checklists, and arrangements for close supervision, investigating unusual or unexpected incidents; and a description of such other details as may be useful in evaluating the existence and effectiveness of safeguards against the hazards of operation of the facility.
- e. A description of plans or proposals in the event that acts or accidents occur which would create radiological hazards. The description shall relate the various operational procedures, the protective devices, and the pertinent features of the site, to such happenings as operational mistakes, equipment or instrument failure or malfunction, fire, electric power failure, flood, earthquake, storm, strike and riot.
- f. Meteorological, hydrological, geological, and seismological data necessary for evaluating the measures proposed for

protecting the public against possible radiological hazards.

g. An evaluation of the proposed measures and devices to prevent deliberate or accidental acts which would create radiological hazards or to protect against the consequences should such events occur.

Procedures for Processing Reactor Hazards Summary Reports Submitted by AEC Contractors

a. The responsible Manager of Operations shall obtain a Hazards Summary Report from the contractor proposing to construct a new, or to significantly modify an existing reactor, and submit 20 copies of such Hazards Summary Report to the responsible Operating Division.

b. The responsible Operating Division Director shall review the Hazards Summary Report for completeness and obtain any additional information required for an evaluation of the hazards associated with the proposed facility, prepare such comments as are considered appropriate, and forward 20 copies of the report to the Reactor Hazards Evaluation Staff.

c. The Reactor Hazards Evaluation Staff shall review the Hazards Summary Report, determine whether it contains adequate information for making a reactor safety evaluation and evaluate the hazards involved in the operation of the proposed reactor as designed. In cases where this evaluation clearly indicates that the hazards are or are not acceptable on the basis of established standards, the Staff shall transmit its findings directly to the responsible Operating Divisions with copies to the Division of Inspection and to the Advisory Committee on Reactor Safeguards. In cases where the hazards involved are so serious, new or unusual, or where there is question as to the acceptability of the hazards on the basis of established standards, the findings shall be submitted to the Advisory Committee on Reactor Safeguards for review.

d. The Advisory Committee on Reactor Safeguards reviews the Hazards Summary Report submitted to it and makes such comments and recommendations as it deems appropriate to the General Manager with copies to the Reactor Hazards Evaluation Staff, the responsible Operating Division and the Divisions of Inspection.

e. In cases involving controversy the Reactor Hazards Evaluation Staff shall submit the facts, with its comments and recommendations to the AGM for Research and Industrial Development. If there is no controversy, the comments and recommendations will be submitted directly to the responsible Operating Division, and a copy to the Division of Inspection.

f. The Director of the responsible Operating Division incorporates the Hazards Summary Report and comments thereto, in the pertinent reactor proposal and makes such recommendations as he deems appropriate to the General Manager.

Representation

The Director of the responsible Division shall arrange for the attendance of one or more technical representatives of the contractor at any meeting at which the Chairman of the committee requests such attendance.

General Criteria for Evaluating Nuclear Hazards

The biological hazards associated with the operation of a nuclear reactor arise chiefly from the production and accumulation of radiologically toxic fission products and secondarily from the neutrons which may stream away from the core of the reactor during operation. Very shortly after the fissioning process stops, the flow of neutrons ceases but the inventory of fission products remains and it is that which may be dispersed from the reactor container following a nuclear and/or a chemical explosion. Weight for weight, the radioactive products of nuclear fission are more toxic than chemical elements by factors of 10^6 to 10^{12}. To illustrate, the usually accepted maximum permissible air concentrations for continuous inhalation of finely divided stable iodine, non-radioactive beryllium (one of the more toxic chemical elements) and radioactive iodine-131 are 1×10^0, 2.0×10^{-3}, and 2.4×10^{-12} mg/m^3, respectively. Therefore, extreme care must be exercised to eliminate or minimize the hazards resulting from the dispersal of these fission products. Considerable effort has been expended in all reactor programs to design and construct reactors which are approximately inherently safe (14). Although the goal to construct inherently safe reactors has not yet been achieved, considerable progress has been made to minimize the probability and the extent of nuclear incidents.

There are many factors which influence the magnitude of both the onsite and the environmental hazards resulting from an uncontrolled release of fission products from a reactor container. In general, the integrated doses received as a result of an incident will depend to a great extent on the following factors:

1. The reactor operation history prior to the incident.
2. The magnitude of the nuclear and/or the chemical incident.
3. The building design.
4. The meteorological conditions.
5. The topographical, hydrological and geological conditions.

Influence of Reactor Operations on Magnitude of Incident

The magnitude of a nuclear incident depends fundamentally on the quantity and quality of fission products released during the incident from the reactor container. In general, there are two types of reactors to evaluate. These are the critical assemblies and the power reactors. The hazards associated with even a major incident in the operation of a critical assembly are usually significantly less than those associated with power reactors. Critical assemblies are operated only for short periods and at watt levels.

The total activity available for dispersion following a critical assembly accident will vary, principally with the design of the reactor. In a critical assembly incident essentially no accumulation of fission products is available in the core prior to the incident. The power output of a critical assembly may reach megawatt levels in a fraction of a second before the products of the reaction separate the fuel and cause the reaction itself to stop. The largest portion of this activity will be composed of short-lived fission products. The quantity of this activity can be estimated by the Wigner-Way equation.

$$A(t) = A(0)\, t^{-n}$$

where:

$A(t)$ = the activity at any time t seconds after the incident,
$A(0)$ = the activity at time zero
t = the time after the incident in seconds
n = approximately 1.2 for values of t from 10 seconds to 100 days.

A determination of the number of curies built up in the reactor as a function of the product of the average power level and the time of the incident can be readily determined by the use of the Wigner-Way equation. Below are given some theoretical and experimental values.

The beta and gamma activities from the dissipation of fission products energy are given by K. Way (15) as $1.40t^{-1.2}$ and $1.26t^{-1.2}$ in mev/sec/fission, respectively. These values are valid for a decay period of 10 seconds to 100 days. Assuming average beta and gamma energies of 0.40 mev/disintegration and 0.58 mev/photon respectively, the beta and gamma activities are $2.94t^{-1.2}$ and $1.82t^{-1.2}$ curies*/watt-sec, respectively. An average energy of 0.58 mev/photon is indicated in Figure 1 when the complete gamma ray spectrum from the fission products is computed for an infinite irradiation period and a 1 day decay period. On

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*For gamma activity, a curie refers to an equivalent curie or 3.7×10^{10} photons/sec.

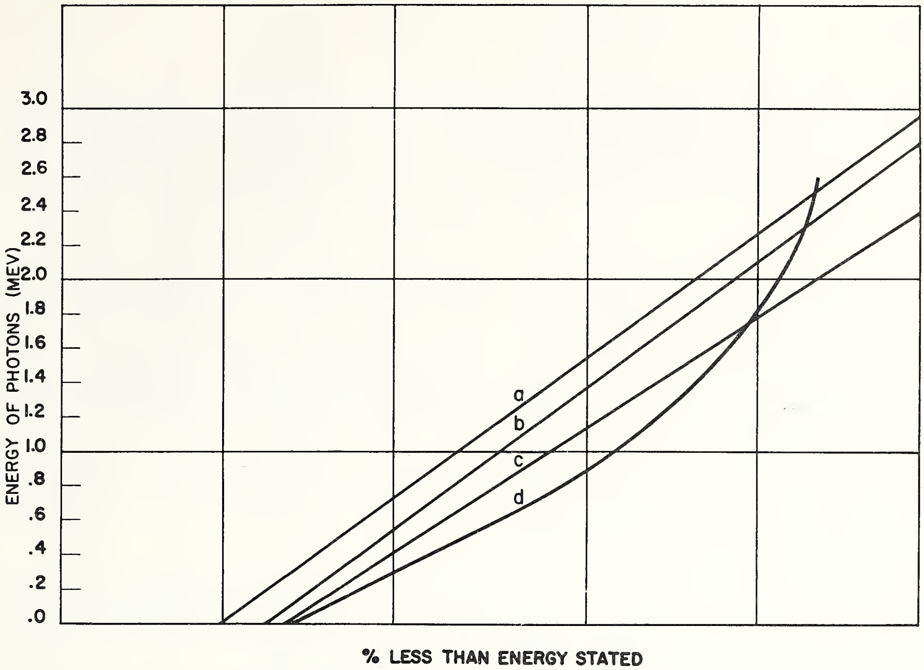

Figure 1. Distribution of Gamma Energies

Key:
- a = APEX-176; 10^3 hours operation; 24 hours decay
- b = Stehn-Clancy; infinite operation; 240 hours decay
- c = Stehn-Clancy; infinite operation; 2400 hours decay
- d = Stehn-Clancy; infinite operation; 24 hours decay

the experimental side, from the Stehn-Clancy (16) activity curves, the beta and the gamma activities are computed to be 3.08 and $1.82t^{-1.2}$ curies/watt-sec, respectively. The values from the Stehn-Clancy curves are used in the calculations which follow.

The activity as a function of the power level can be readily determined by a simple integration.

$$\gamma = \int_0^{t_o} 1.82 (t+t_d)^{-1.2} dt$$

$$= 9.1 \left[t_d^{-0.2} - (t_o + t_d)^{-0.2} \right] \text{curies/watt} \quad (1)$$

$$\beta = \int_0^{t_o} 3.08 (t+t_d)^{-1.2} dt$$

$$= 15.4 \left[t_d^{-0.2} - (t_o + t_d)^{-0.2} \right] \text{curies/watt} \quad (2)$$

where:
- t_o = the operational period of the reactor in seconds
- t_d = the decay period in seconds

The beta activity from a specific isotope is given by the expression:

$$A = 8.46 \times 10^5 y (1 - e^{-\lambda t_o}) e^{-\lambda t_d} \text{ curies/Mw}$$

where:
- y = the fractional yield per fission
- t_o, t_d = the operational and decay periods, respectively, in seconds
- λ = the decay constant in reciprocal seconds

The radioactivity A_2 from an isotope with a decay constant λ_2 which is formed by the decay of an isotope with a yield y_1 and a decay λ_1 is presented by the following formula (17).

$$A_2 = 8.46 \times 10^5 \, y_1 \left[1 - \left(\frac{\lambda_1 e^{-\lambda_2 t_o} - \lambda_2 e^{-\lambda_1 t_o}}{\lambda_1 - \lambda_2} \right) \right]$$

Table 3. Fission Product Yields and Saturated Activities

Nuclide	Half Life	Fission Yield in %	Beta or Conversion Electron		Gamma		Saturated Beta Activity, No Decay in 10^4 c/Mw
			Max. Energy, in Mev	No. of Betas per dis.	Energy per dis., in Mev	No. of Photons per dis.	
As-77	39 h	0.02	0.69	1.00			0.017
Kr-85	9.4 y	0.32	0.69	1.00	0.51	0.006	0.27
Sr-89	54 d	4.40	1.48	1.00			3.72
Sr-90	20 y	5.50	0.54	1.00			4.64
Y-90	61 h	5.50	2.18	1.00			4.64
Sr-91	9.7 h	5.60	1.1	0.33	0.55	0.40	4.74
			1.4	0.29	0.64	0.33	
			2.66	0.26	1.03	0.33	
			0.6	0.07	0.66	0.22	
			2.0	0.04	0.75	0.07	
					1.41	0.07	
Y-91	61 d	5.60	1.55	1.00	1.2	0.001	4.74
					0.2	0.001	
Y-93	11 h	6.1	3.1	1.00	(0.7)	0.50	5.17
Zr-95	65 d	6.37	0.37	0.99	0.72	0.99	5.38
			0.84	0.01			
Nb-95	37 d	6.37	0.16	1.00	0.75	1.00	5.38
Zr-97	17 h	6.1	1.91	1.00	0.75	1.00	5.17
Nb-97	75 m	6.1	1.27	1.00	0.66	1.00	5.17
Nb-99	67 h	8.0	1.22	0.80	0.73	0.20	6.76
			0.45	0.20	0.18	0.20	
					0.78	0.03	
					0.37	0.02	
					0.14	0.02	

Ru-103	40 d	2.40	0.20	0.94	0.50	0.94	2.03
			0.68	0.06			
Ru-105	36 h	0.75	0.57	0.95	0.32	0.05	0.634
			0.25	0.05			
Ru-106	1.0 y	0.35	0.04	1.00			0.296
	30 s	0.35	3.53	0.68	0.51	0.31	0.296
			2.5	0.12	0.62	0.16	
			3.1	0.11	1.04	0.03	
			1.1	0.06	0.87	0.01	
			2.0	0.03	1.55	0.01	
					2.4	0.003	
Sb-125	2.7 y	0.02	0.30	0.49	0.43	0.45	0.017
			0.13	0.33	0.60	0.24	
			0.62	0.18	0.11	0.18	
					0.17	0.17	
					0.64	0.12	
					0.46	0.11	
Sb-127	95 h	0.067	1.2	1.00	0.7	1.00	0.057
Te-127	9.3h	0.067	0.7	1.00			0.057
Sb-127	95 h	0.013	1.2	1.00	0.7	1.00	0.011
			(e)				
Te-127m	110 d	0.013	0.05	1.00			0.011
Te-127	9.3h	0.013	0.7	1.00			0.011
			(e)				
Te-127m	110 d	0.020	0.05	1.00			0.017
Te-127	9.3h	0.020	0.7	1.00			0.017
			(e)				
Te-129m	38 d	0.32	0.07	1.00			0.271
Te-129	70 m	0.32	1.8	1.00	0.8	(0.50)	0.271
					0.3	(0.50)	
			(e)				
Te-131m	30 h	0.45	0.14	1.00			0.381
Te-131	25 m	0.45	2.0	1.00	2.5	0.22	0.381
I-131	8.14d	0.45	0.61	0.87	0.36	0.80	0.381
			0.33	0.09	0.64	0.09	
			0.25	0.03	0.28	0.05	
			0.81	0.01	0.72	0.03	

Table 3. Fission Product Yields and Saturated Activities (Continued)

Nuclide	Half Life	Fission Yield in %	Beta or Conversion Electron		Gamma		Saturated Beta Activity, No Decay in 10^4 c/Mw
			Max. Energy, in Mev	No. of Betas per dis.	Energy per dis., in Mev	No. of Photons per dis.	
I-131	8.14 d	2.55	0.61	0.87	0.36	0.80	2.16
			0.33	0.09	0.64	0.09	
			0.25	0.03	0.28	0.05	
			0.81	0.01	0.72	0.03	
Te-132	77 h	4.47	0.22	1.00	0.23	1.00	3.77
I-132	2.4 h	4.47	2.2	0.87	0.7	0.97	3.77
			0.9	0.13	1.4	0.11	
					2.0	0.027	
I-133	21 h	6.3	1.4	0.94	0.53	0.99	5.32
			0.5	0.06	0.85	0.05	
					1.4	0.01	
Xe-133	5.27 d	6.3	0.34	1.00	0.08	0.61	5.32
			(e)				
			0.05	0.39			
I-133	21 h	0.16	1.4	0.94	0.53	0.99	0.135
			0.5	0.06	0.85	0.05	
					1.4	0.01	
			(e)				
Xe-133m	2.3 d	0.16	0.20	0.81	0.23	0.19	0.135
Xe-133	5.27 d	0.16	0.34	1.00	0.08	0.61	0.135
			(e)				
			0.05	0.39			
I-135	6.7 h	7.0	1.0	0.40	0.52	0.30	5.90
			0.5	0.35	1.3	(0.26)	
			1.4	0.25	1.8	0.04	
					2.4	0.0114	
Xe-135	9.2 h	7.0	0.9	1.00	0.25	0.95	5.90
			(e)				
			0.22	0.05			

Cs-137	33	y	6.15	0.51	0.95			5.20
				1.17	0.05			
				(e)				
Ba-137	2.6	m	6.15	0.62	0.10	0.66	0.85	5.20
Ba-140	12.8	d	6.4	1.02	0.60	0.54	0.25	6.65
				0.48	0.40	0.31	0.15	
						0.16	0.15	
La-140	40	h	6.4	1.3	0.70	1.6	0.75	
				1.7	0.20	0.49	0.29	
				2.3	0.10	0.82	0.21	6.65
						2.5	0.04	
						0.33	0.04	
						3.0	0.001	
Ce-141	32	d	6.3	0.44	0.67	0.15	0.43	6.60
				0.58	0.33			
				(e)				
				0.10	0.24			
Ce-143	33	h	5.8	1.37	0.40	0.28	0.70	4.92
				1.1	0.30	0.71	0.15	
				0.4	0.30	0.65	0.15	
Pr-143	1.35	d	5.8	0.92	1.00			4.92
Ce-144	280	d	5.0	0.30	0.70	0.13	0.30	4.23
				0.17	0.30			
Pr-144	17	m	5.0	2.97	0.90	2.18	0.025	4.23
				2.3	0.05	0.70	0.023	
				0.8	0.05	1.48	0.01	
Nd-147	11.6	d	2.45	0.78	0.65	0.09	0.33	2.07
				(e)				
				0.04	0.33	0.52	0.32	
				0.35	0.32	0.39	0.02	
				0.47	0.03	0.31	0.01	
Pm-147	2.6	y	2.45	0.23	1.00			2.07
Pm-149	55	h	1.28	1.05	1.00	0.28	(0.20)	1.08
						(1.3)	(0.05)	

Table 3. Fission Product Yields and Saturated Activities (Continued)

Nuclide	Half Life	Fission Yield in %	Beta or Conversion Electron		Gamma		Saturated Beta Activity, No Decay in 10^4 c/Mw
			Max. Energy, in Mev	No. of Betas per dis.	Energy per dis., in Mev	No. of Photons per dis.	
Pm-151	27 h	0.48	1.1	1.00	0.71 0.34 0.27 0.10	(0.50) (0.50) (0.50) (0.50)	0.406
Sm-151	73 y	0.48	0.076	1.00	0.02	(1.00)	0.406
Sm-153	46 h	0.11	0.68	0.67	0.10	(0.20)	0.093
			(e) 0.05	(0.40)	0.07	(0.05)	
			0.80	0.33			
			(e) 0.09	(0.08)			
Eu-155	1.7 y	0.05	0.15 0.24	0.80 0.20	0.10	(0.80)	0.042
Eu-156	15 d	0.03	0.5 2.4	0.60 0.40	2.0	0.60	0.025

To illustrate the use of these activity-operational time relationships, the beta and gamma activities built up during a one megawatt-sec critical assembly incident are

$3.08 \times 10^6 t^{-1.2}$ and

$1.82 \times 10^6 t^{-1.2}$ curies, respectively. In 32 seconds after the incident, the total activities are approximately a factor of 64 less than the activities at 1 second after the incident, as indicated in Figure 7. For infinite operations, ($t_o = \infty$) at a power level of 100 megawatts, the gamma and beta activities are

$9.1 \times 10^8 t_d^{-0.2}$ equivalent curies and $15.4 \times 10^8 t_d^{-0.2}$ curies, respectively, as indicated by Equations 1 and 2. These activities are reduced only by a factor of 2 during a period of 32 seconds following the incident which was preceded by an infinite operational period. The fractional decays following a long period of operation ($t_o >> t_d$) are given in Figure 8.

Magnitude of the Incident

The release of the fission products may result from a nuclear and/or a chemical incident. If the incident is a major one, rupturing the reactor container and fracturing the building, the hazard to the environs may be significant. If the incident is large enough to release all of the activity instantaneously, the cloud may rise high enough to reduce substantially the external doses and to eliminate the internal doses. In most instances, the activity will probably be released over a relatively long period of time. In general, it is assumed in the calculations that the cloud does not rise and that the center of the fission products cloud passes directly through the observer.

Building Design

If the power plant building is constructed properly one may maintain the integrity of the building following a maximum incident. A leakage rate of less than 1 or 2% in 24 or 48 hours may be adequate to afford the necessary protection to the environs. The power plant building is the last line of defense between the release of the fission products and the environs. An experimental determination of the leakage of gases from the power plant building to the atmosphere is desirable prior to power operations. Periodic tests are desirable to determine the leakage because of penetrations after power operations are initiated. Ventilation systems must be designed to close automatically in the event of a serious incident. A water spray system located at favorable positions in the building may be useful to reduce temperature and corresponding pressure rises in the event of a major incident. This water will also be useful in washing out some of the fission products. Thus, the fraction of radioactive material released from the building following the incident may be materially reduced by this action. The building should be designed to maintain its integrity even at maximum pressure rises. Provisions within the building should be made to protect the building structure itself from being penetrated by missiles. A well-designed power plant building is expensive, but if it affords maximum protection to the environs and if it reduces the cost of the exclusion area, it can be an excellent investment.

Meteorological Conditions

Once the activity has been released from the power plant building to the atmosphere, the radiological hazards to the environs because of the activity released depend largely upon the meteorological conditions.

The following is a general formula (18) which may be applied to the problem of determining dose either inhaled or external, due to a calculated release of activity in the form of a burst or cloud.

$$X = \frac{Q}{\pi^{3/2} C_d^3 (x_v+vt)^{\frac{3(2-n)}{2}}} \cdot e^{\left[-\frac{r^2}{C_d^2 (x_v+vt)^{2-n}}\right]}$$

Where:

X = concentration at point of interest

Q = total amount of activity in cloud

r = distance from the center of cloud to point of interest

x_v = distance from the virtual origin to origin of the incident

C_d = coefficient of diffusion

n = stability parameter
v = wind velocity
t = time at which the measurement is made following the incident

Since meteorological conditions can be very variable, for purposes of discussion only two types of meteorological conditions are generally evaluated. These conditions are the lapse and the inversion cases. During inversion conditions, the cloud cannot rise above the inversion layer unless the heat from the incident is sufficient to break through a low enough lying inversion layer. In the inversion case therefore the doses are higher than in the lapse case since the diffusion rates are smaller and the stability factor, n, is larger. The dose from the passage of the fission products cloud (18) following a critical assembly incident varies with $v^{0.2}$ while the dose from the power reactor incident varies with $v^{-0.8}$. The difference is due to the decay of the fission products activity in the first case according to the $t^{-1.2}$ Law and in the second case according to the $t^{-0.2}$ Law. In these calculations, the value of t is approximately equal to X_o/v, where X_o is the distance from the incident in meters at which the dose is determined. The wind velocity, v, is in meters/second. In general, the inversion case doses are taken to be a factor of 5 greater than the lapse case doses at a quarter mile distance from the incident when the wind velocities are the same in each case. At a distance of three miles from the incident the inversion case doses are approximately 10 times the lapse case doses.

The meteorological factors considered are listed below:

1. Wind direction and frequency of direction.
2. Surface and aloft wind speeds.
3. Types of gustiness.
4. Miniumm, maximum and mean temperatures on an hourly, monthly and annual basis.
5. Frequency and duration of inversions.
6. Average and maximum quantity of precipitation (snow and rain) on a daily, monthly and annual basis.

An evaluation of the atmospheric stability may be made from the temperature measurements at various heights. The frequency, altitude and duration of inversion conditions together with the wind velocity and direction at various heights should also be recorded. In general, the stability parameter n, which varies from 0 to 1, is approximately 0. 5 for inversion conditions and 0. 25 for lapse meteorological conditions. The coefficient of diffusion, C_d, has specific values in the x, y and z directions. At heights greater than 25 meters, however, $C_x = C_y = C_z$. In general one may consider C_d as an average coefficient of diffusion where $C_d = (C_xC_yC_z)^{1/3}$. If the value of C_d has not been experimentally determined for the site, an average coefficient of diffusion of 0. 06 $\text{meter}^{1/4}$ and 0. 12 $\text{meter}^{1/8}$ may be assumed for inversion and lapse meteorological conditions, respectively.

An experimental determination of the diffusion coefficients and the atmospheric dilution at a proposed reactor site can be made by the use of oil smoke and fluorescent particles. The oil smoke particles can be used to determine visually the atmospheric dilution and the diffusion of particles in the atmosphere, while the fluorescent particles can be used for an accurate determination of the diffusion coefficients.

Topographical, Hydrological and Geological Conditions

The hazard to the environs depends initially on the meteorological conditions; however, unfavorable topographical, hydrological and geological conditions can accentuate the hazard. Topographical, hydrological and geological conditions must be evaluated in the selection of a site for a reactor. The topography influences the immediate meteorological conditions in the area. For example, the meteorological conditions may be significantly different in locations only 100 meters apart but separated by a sharp rise and/or a deep depression in the earth's surface. The presence of a water system which supplies water for drinking, bathing or fishing purposes in the vicinity of a reactor site must be evaluated. The geological aspects are important in view of the possible fixation of fission products in the soil following a nuclear incident. The extent of the hydrological and geological evaluation necessary depends on the estimated level and quality of radioactive material that may be deposited in the environment at the proposed site.

The geological and hydrological survey (19) of a reactor area would be expected to contain the following information.

Geology

1. Depth and nature of overburden
2. General area information
3. Stratigraphy of bedrock formations
4. Soil characteristics pertinent to plant waste

Hydrology

1. General area information
2. Elevation of water table
3. Direction, rate and nature of underground movement of wastes and water
4. Effect of withdrawals or recharge
5. Surface streams
6. Stream flow and impoundments
7. Study of water quality (chemical and physical)

In addition to these factors, it may be desirable to determine the potential hazards associated with the deposition of radioactive material in the water systems. The quantity and quality of radioactive materials deposition on suspended river sediment and in the bottom mud should be investigated. If radioactive laboratory waste may be discharged into a stream used for fishing, bathing and/or drinking purposes, a detailed study on the dilution of the radioactivity in the stream, the concentration of radioactivity in mud, vegetation, plankton and fish should be conducted (20).

A Simplified Method for Evaluating Radiation Hazards From a Nuclear Incident

Introduction

An evaluation of the hazards associated with the operation of a critical assembly and/or a power reactor can be made when the general criteria for evaluating these hazards, as previously stated, are known. The fundamental dosage determinations that must be made are listed below.

External Dose Determinations

- Direct radiation exposure
- Fission products cloud exposure
- Fall-out radiation exposure
- Submersion exposure

Internal Dose Determinations

- Inhalation exposures
- Ingestion exposures

A method (18) has been developed to estimate these dosages and the derivations of new formulas are discussed in detail. The available beta and gamma activity as a function of operational time and power level has been discussed previously in this section. The data presented in graphic form are based on the formulas developed in KAPL-1045 (18), KAPL-1178 (21), and KAPL-1527 (22). The exposures from a nuclear incident involving a critical assembly and a power reactor are given in terms of kw-sec and megawatts, respectively. The exposures from the critical assembly will be presented first. However, it appears appropriate here to discuss some of the assumptions that have been made in the calculation of these exposures.

The dose-rates from the direct radiation exposure to the fission products contained within a power plant building were computed by an analysis of the individual dose-rates from the ranges of photon energies indicated in Figure 1. It would not be correct to compute the dose-rates on an average energy basis, since the absorption and build-up factors in steel vary considerably with the energy of the photon. In the determination of the air scatter, energy absorption coefficients (which combine the attenuation in air and the build-up factors) were used. The dose from ground scatter is very small and was neglected.

The direct radiation from other activated materials (coolant or structural material) in some instances may contribute significantly to the direct radiation dose, and therefore, should be considered in the determination of the total direct radiation dose.

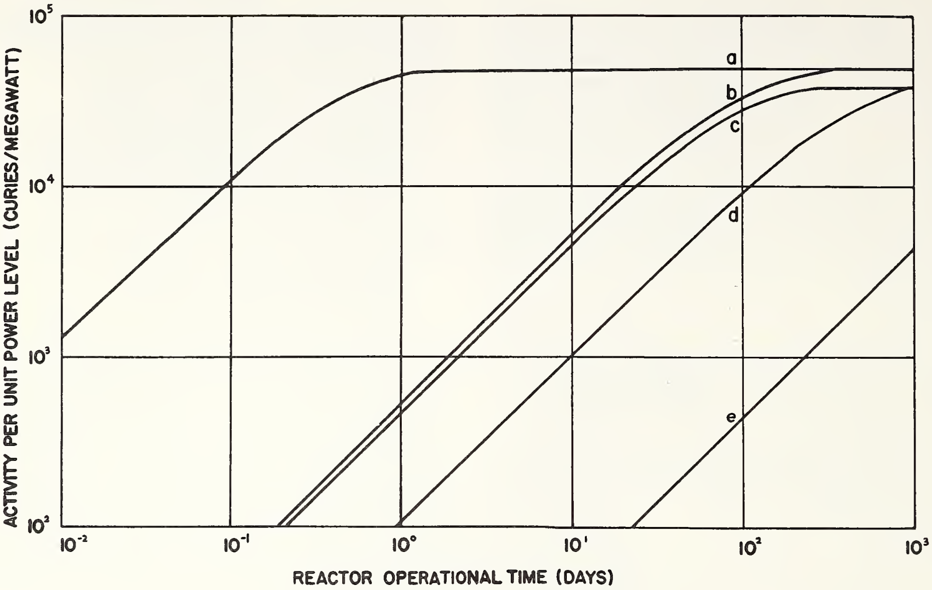

Figure 2. Initial Activity of Bone Seekers from Fissioning of U-235

Key: a = Sr-91; b = Y-91; c = Sr-89; d = Ce-144; e = Sr-90

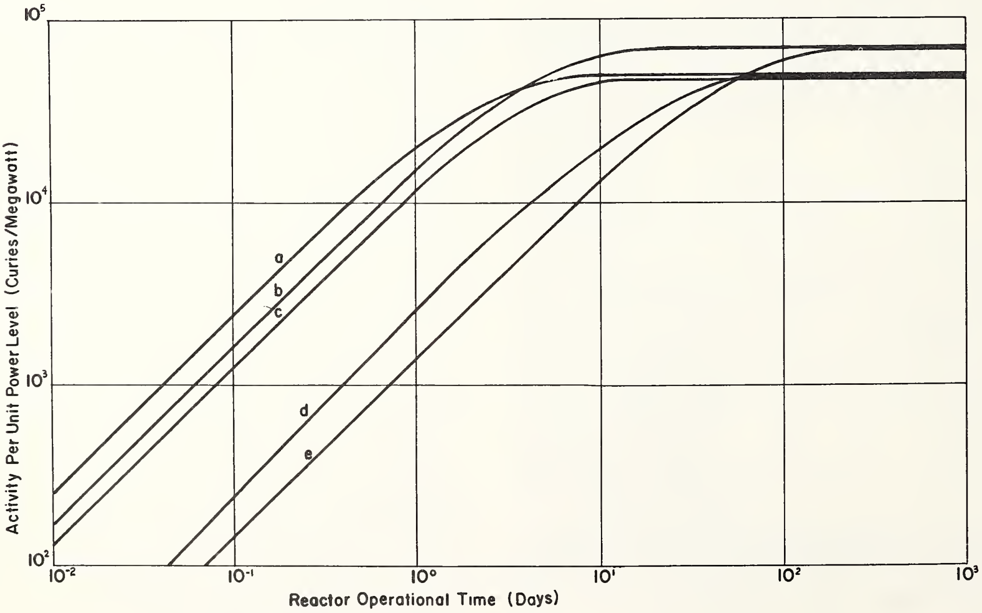

Figure 3. Initial Activity of Bone Seekers from Fissioning of U-235

Key: a = Ce-143; b = Mo-99; c = Y-90; d = Pr-143; e = Ce-141

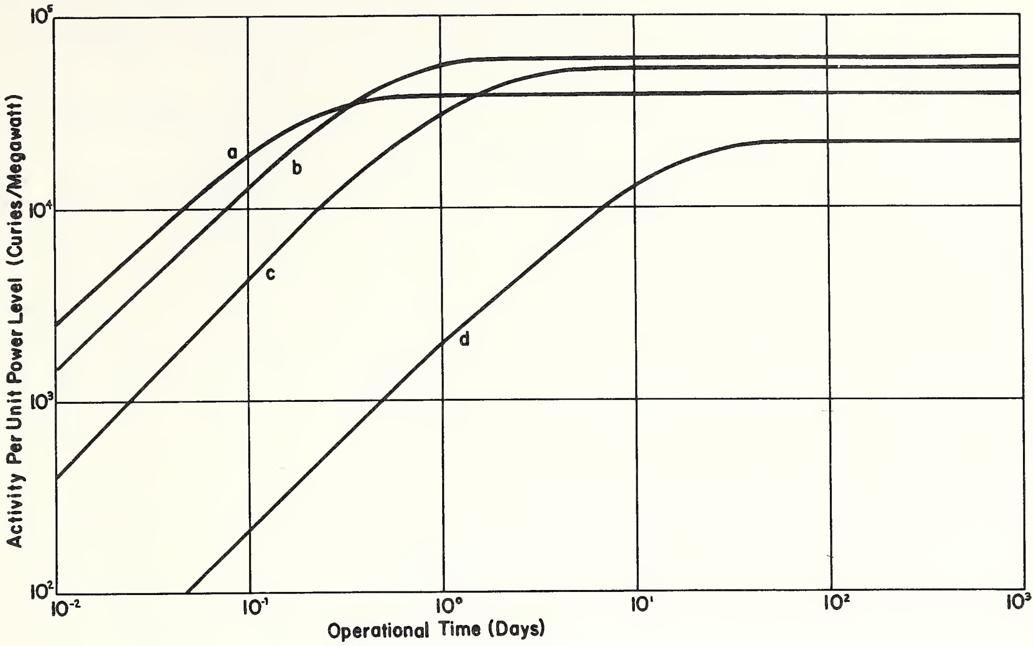

Figure 4. Initial Activity of Thyroid Seekers from Fissioning of U-235

Key: a = I-132; b = I-135; c = I-133; d = I-131

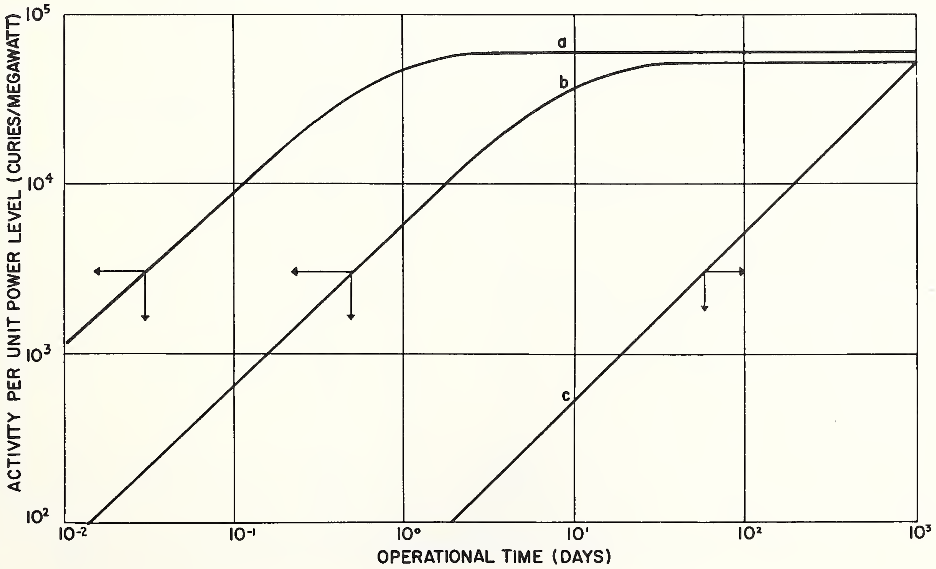

Figure 5. Initial Activity of Radiogases from Fissioning of U-235

Key: a = Xe-135; b = Xe-153; c = Kr-85

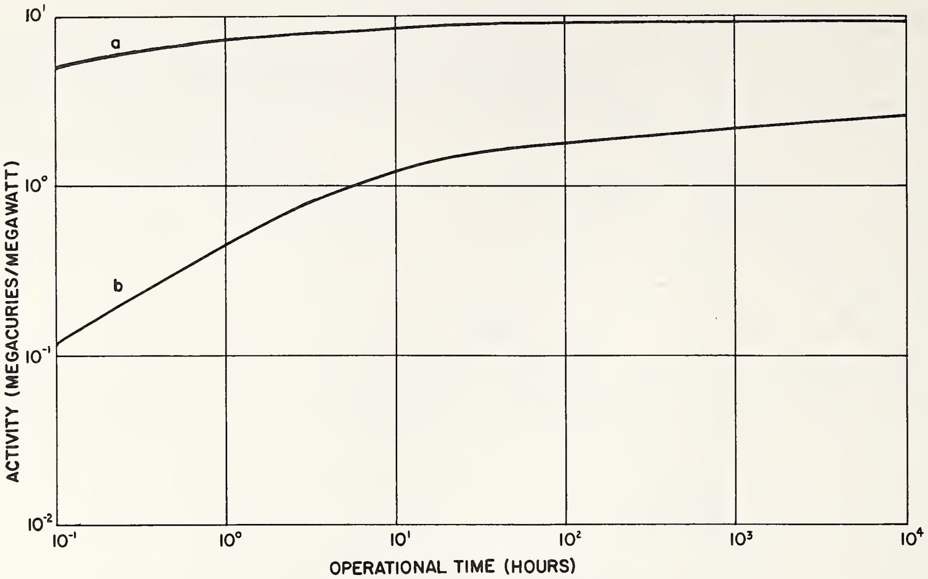

Figure 6. Total Beta Activity from Fissioning of U-235

Key: a = 10 seconds decay; b = 3600 seconds decay

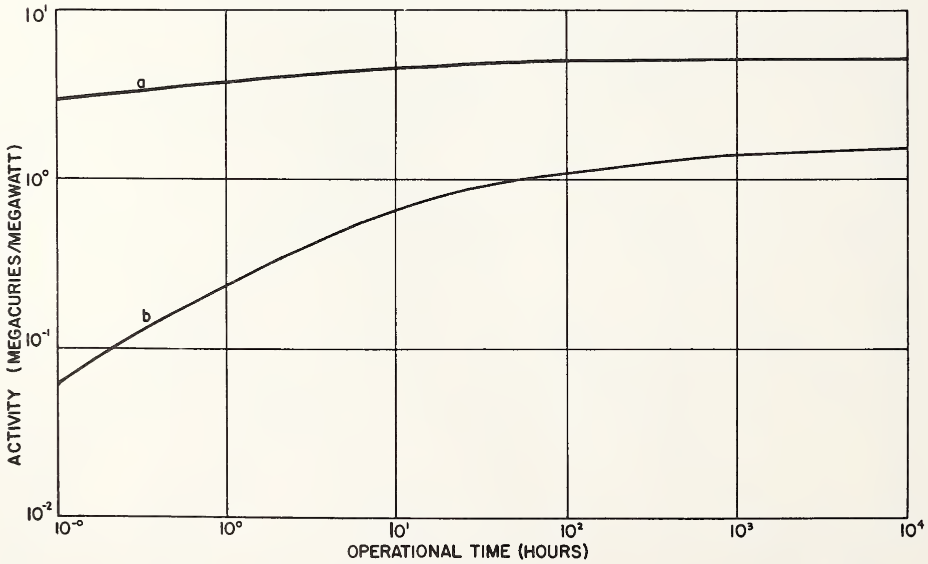

Figure 7. Total Gamma Activity from Fissioning of U-235

Key: a = 10 seconds decay; b = 3600 seconds decay

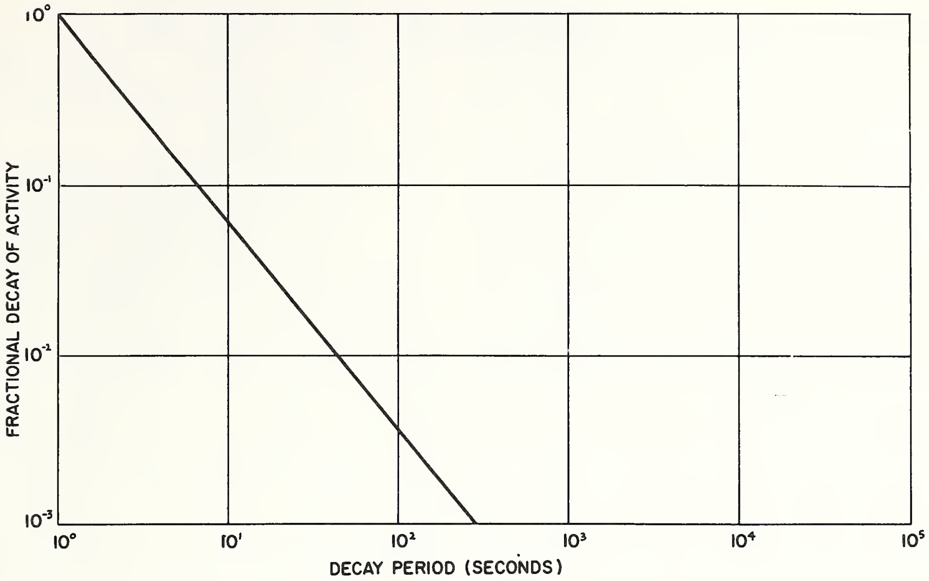

Figure 8. Short Lived Fission Products; Decay from Fissioning of U-235

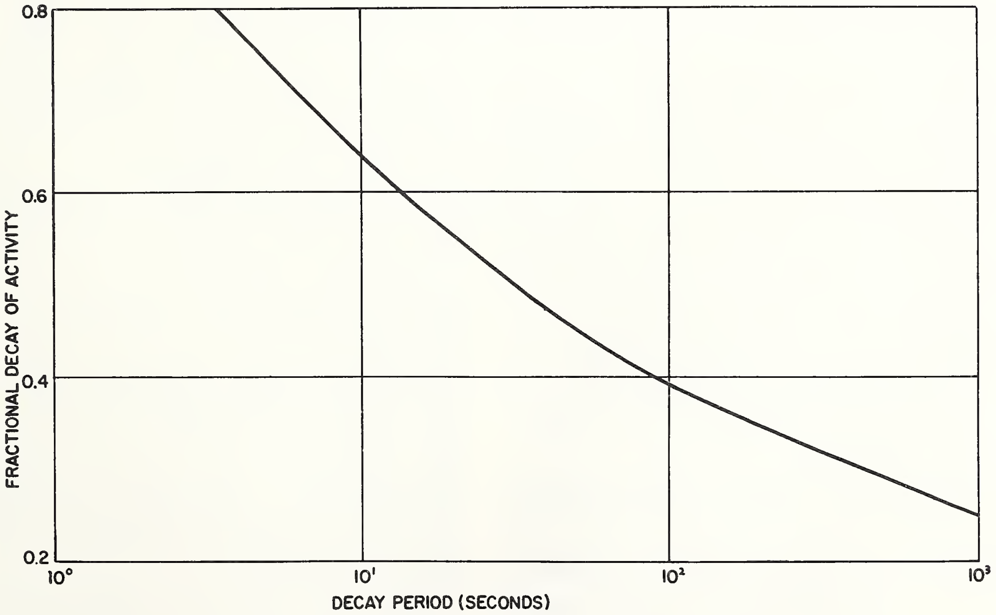

Figure 9. Long Lived Fission Products; Decay from Fissioning of U-235

The doses from the passing of the fission products cloud were computed by assuming an average gamma energy per photon of 0.7 mev. No air scattering was computed. At distances close to the origin of the incident the air scattering is not important, but, as the cloud increases in size, it should not be neglected. In these calculations, it was assumed that the cloud traveled along the ground and the center of the cloud passed through the observer. In addition, it was assumed that there was no fallout of radioactivity. These factors tend to maximize the dose and, therefore, no air scattering was included in these calculations. It should be noted that these calculations are based on the irradiation of a body by a finite cloud of fission product activity. The well-known formula* frequently used to estimate the exclusion area for a power plant building (which cannot contain the fission products) was based on an infinite cloud irradiation. A comparison of the calculated doses yielded by these two methods indicates that the infinite cloud method overestimates the dose to observers at distances of 100 meters and one mile by factors of 100 and 10, respectively. The exclusion area or distance for power plant build-up which can contain all of the fission products is based on the direct radiation dose.

The internal dose** from the inhalation of the fission products was determined by making the following assumptions:

1. The cloud does not rise.
2. The concentration of fission products in the cloud is a Gaussian function of the distance measured from the center of the cloud.
3. The exposed person remains in the center path of the cloud at a specified distance from the origin.
4. The dose to the critical organ for each specific isotope was computed from the beginning of the inhalation to infinity.

The total iodine dose to the thyroid will be received in approximately 54 days. The total Sr-89 and Sr-90 doses to the bone will be received in approximately one year and 52.5 years, respectively. Approximately one-half of the total Sr-90 dose to the bone will be received over a period of 7.5 years. Therefore, corrections for the Sr-90 dose can be made as a function of time over which the bone is irradiated. Approximately 75% of the total dose to the bone from Ce-144 will be achieved in a period of one year, as indicated in Figure 10.

In the assessment of the maximum permissible damage that may be inflicted on an individual under emergency conditions, one finds a lack of official standards for such conditions. It is difficult, however, to establish standards which could cover the majority of emergency conditions and be rationally acceptable to all concerned. Certainly, it is not realistic to observe the conservative lifetime maximum permissible dose limits to a man when he may, under the same emergency conditions, be also subjected to fire, explosion and/or chemical hazards more damaging to the body than the associated radiation. In addition, the period of exposure under emergency conditions may be brief and such an exposure may occur only once in a lifetime. Therefore, it is natural that one would expect the standards for emergency conditions to be significantly different from those for statistical lifetime exposure conditions.

The only official maximum permissible emergency radiation exposure standards at the present time are those recommended by the National Committee of Radiation Protection (23). As stated in NBS Handbook 59, exposures greater than the maximum permissible lifetime exposures are permitted in the individual perform-

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*The exclusion distance, D, in miles has been computed by the use of the formula, $D = 0.01\ (kw)^{1/2}$ where kw is the average operating level in kilowatts. For example, if a reactor is operated at an average power level of 10,000 kw or 10 megawatts, the exclusion area will be 1 mile.

**The method for computing the internal dose is given in detail in KAPL-1178 (21) with nomograms to aid in the calculations.

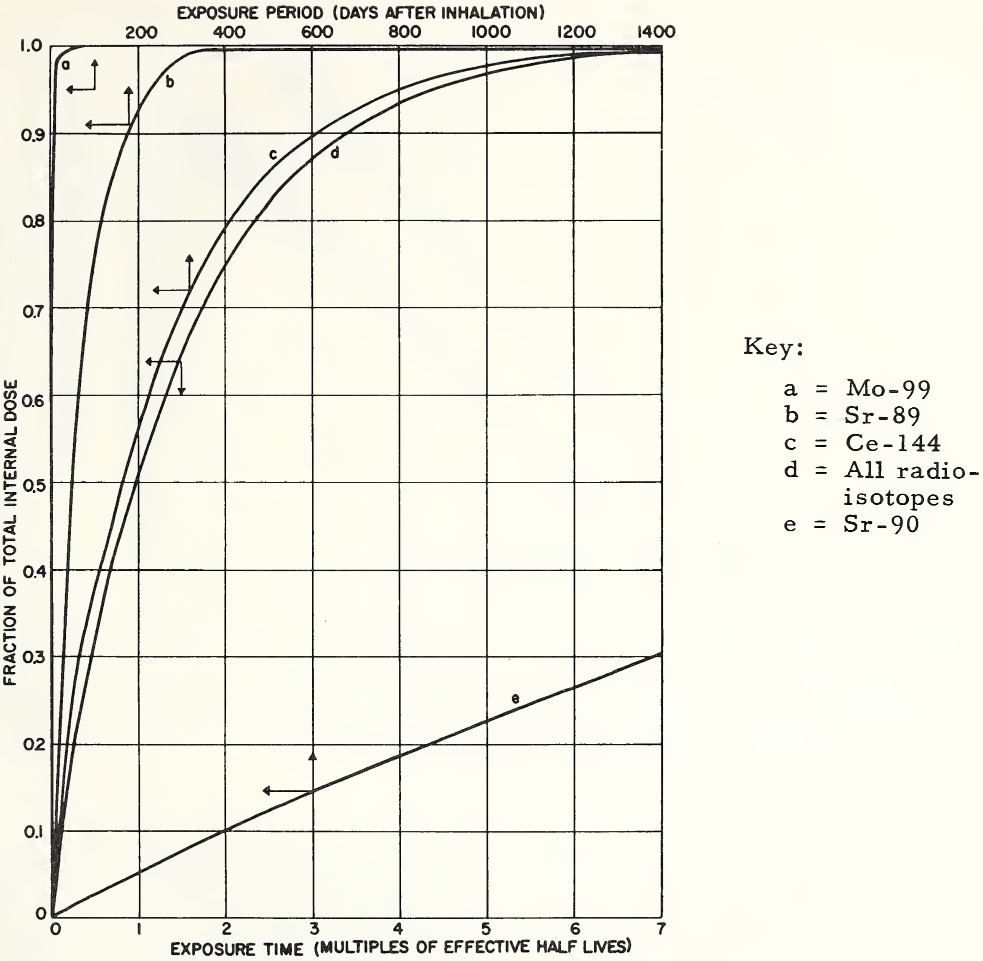


Figure 10. Exposure Time-Correction Factor Relationship for Finite Exposure Periods

ance of an unusual task to protect himself, others, or valuable property. A maximum emergency dose of 25 roentgens from an external source is permitted provided that an exposure of this magnitude is permitted by an individual only once during his lifetime. The maximum permissible emergency dose to the hands and forearms as well as to the feet and the ankles is 100 roentgens under the same conditions.

Although no official standards on internal doses have been recommended by the National Committee on Radiation Protection, doses of 100 rep to a critical organ (lung, bone, thyroid, etc.) over a period of 60 days appear to be acceptable provided that not more than 15% of this dose is received during the first day following the inhalation. Under these circumstances, however, larger doses may be acceptable since the doses are received over a period of time and action may be possible to increase the excretion rate of fission products concentrated in the body. Thus the total dose to the body will be reduced.

Critical Assembly Hazard Evaluation

Direct Radiation Exposure

The dose-rates from the fission products contained within a 2-inch steel container are given in Figure 11 as a function of distance from the origin of the incident, 10 seconds after the incident occurred. The dose-rate at a time, t seconds after the incident,

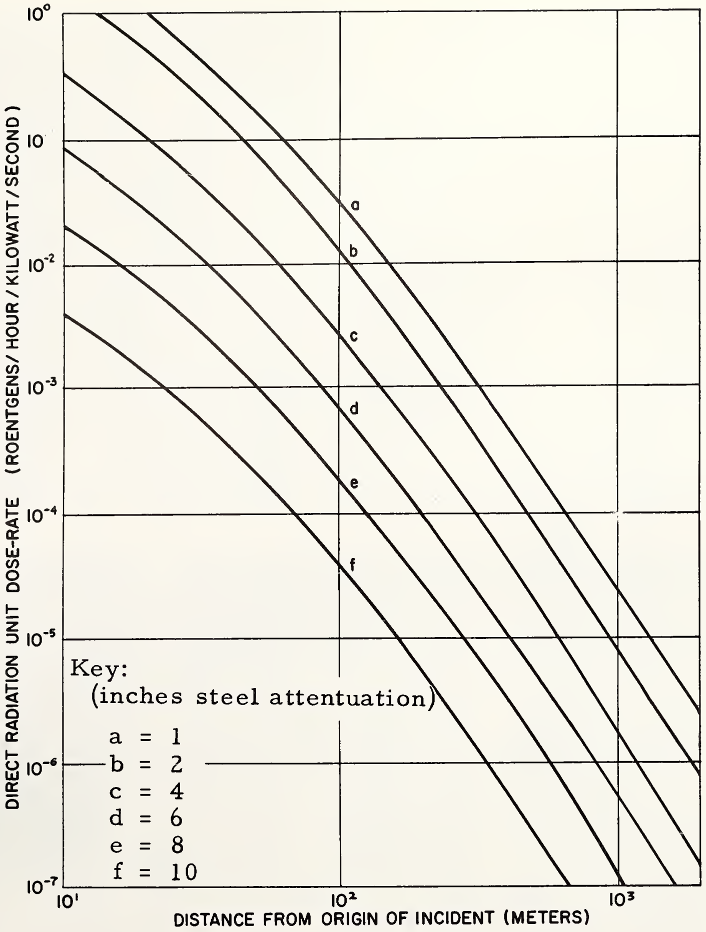


Figure 11. Critical Assembly Data
Direct Radiation Unit Dose Rate. Assume standard "build-up" factors, energy attenuation in air and a point source.

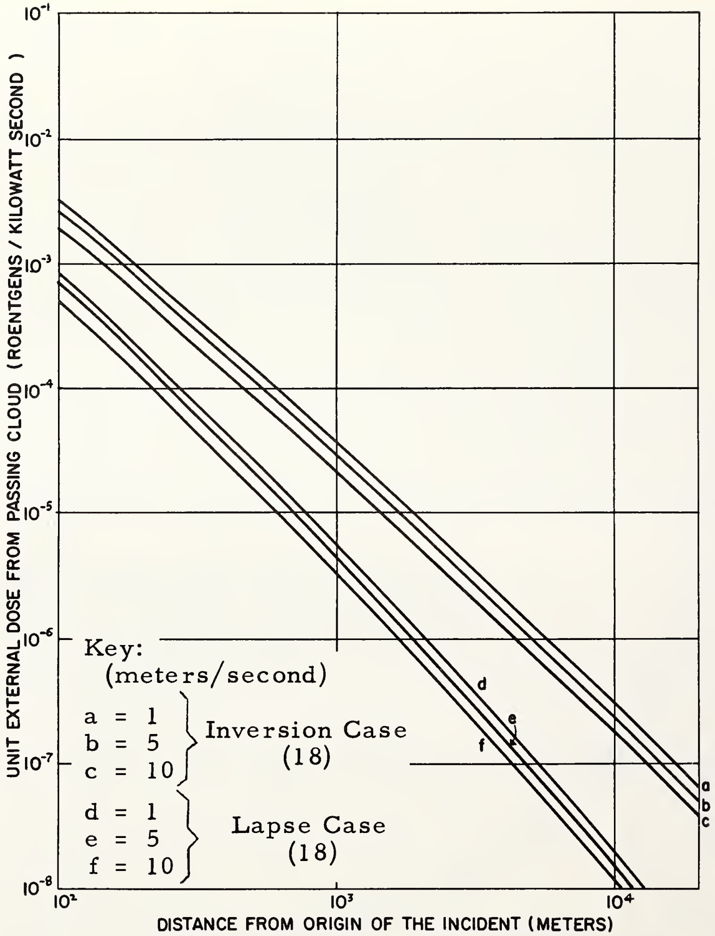


Figure 12. Critical Assembly Data
Integrated External Dose from the Passage of a Fission Products Cloud Due to 100% Instantaneous Point Source Release from a Critical Assembly Incident.

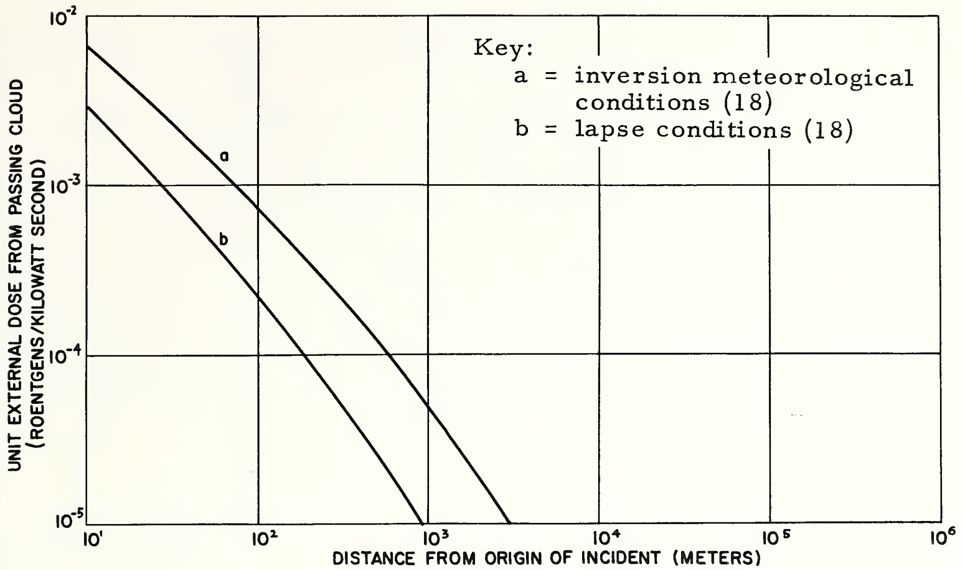


Figure 13. Critical Assembly Data

Integrated External Dose from Passage of Fission Products Cloud Following the Continuous Release of the Fission Products over a 2-hour Period. Assume continuous point source emission over a 2-hour period, 100% release, wind velocity of 1 meter/second, E = 0.7 mev/disintegration, $\mu = 0.0035\ m^{-1}$.

can be obtained by multiplying the dose-rate curve presented in Figure 11 by $(0.1t)^{-1.2}$. For example, the dose-rate from direct radiation at a distance 100 meters from the origin 10 seconds after the incident will be 1.1×10^{-2} r/hr/kw-sec through two inches of steel. The dose-rate at the same position one hour after the incident is reduced by a factor of $(360)^{-1.2}$. Therefore, the dose-rate at one hour following the incident will be 9×10^{-6} r/hr/kw-sec.

Fission Products Cloud Exposure

The dose from an instantaneous release of fission products as a cloud moving along the ground and passing through an observer at x meters from the origin of the incident is presented in Figure 12 for both lapse and inversion meteorological conditions. The dose from the continuous release of the activity of a period of 2 hours is given in Figure 13. For periods of release equal to or greater than 1 hour, the dose at a distance x meters from the origin is equal to the product of the dose given in Figure 13 and $[(\tau \text{ hours})/2]^{-1.2}$. For example, for a release period of 4 hours, the doses are multiplied by 0.437. For wind velocities other than 1 meter/second, the corresponding doses are obtained by multiplying the doses given in Figure 13 by $v^{0.2}$.

Fall-Out Radiation Exposure

The integrated fall-out doses are presented in Figure 14. These doses are the integrated doses from the maximum fall-out at each position. It should be noted that the assumption of maximum fall-out at each distance yields values much greater than normally would be expected. For example, at a distance of 100 meters from the accident in the lapse case where the cloud velocity is five meters/sec, the assumption corresponds to a fall-out rate of five percent per minute for the anticipated particle sizes. The doses obtained must be too large by a factor of the order of 100 at this distance. The only way in which fall-out cases of the calculated magnitude could be

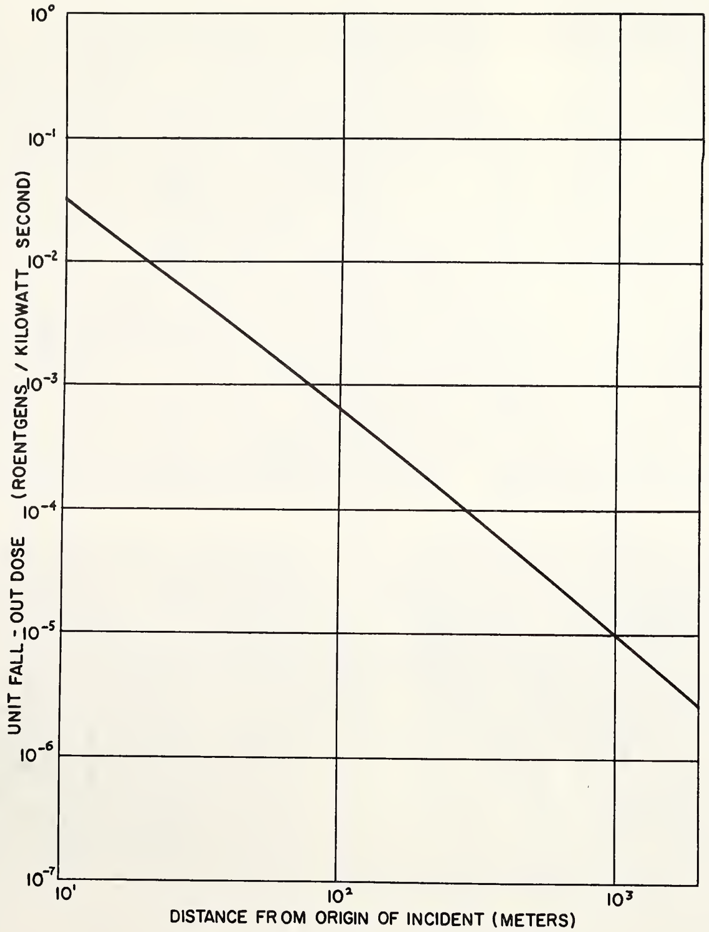


Figure 14. Critical Assembly Data. Integrated Unit Fall-Out Dose

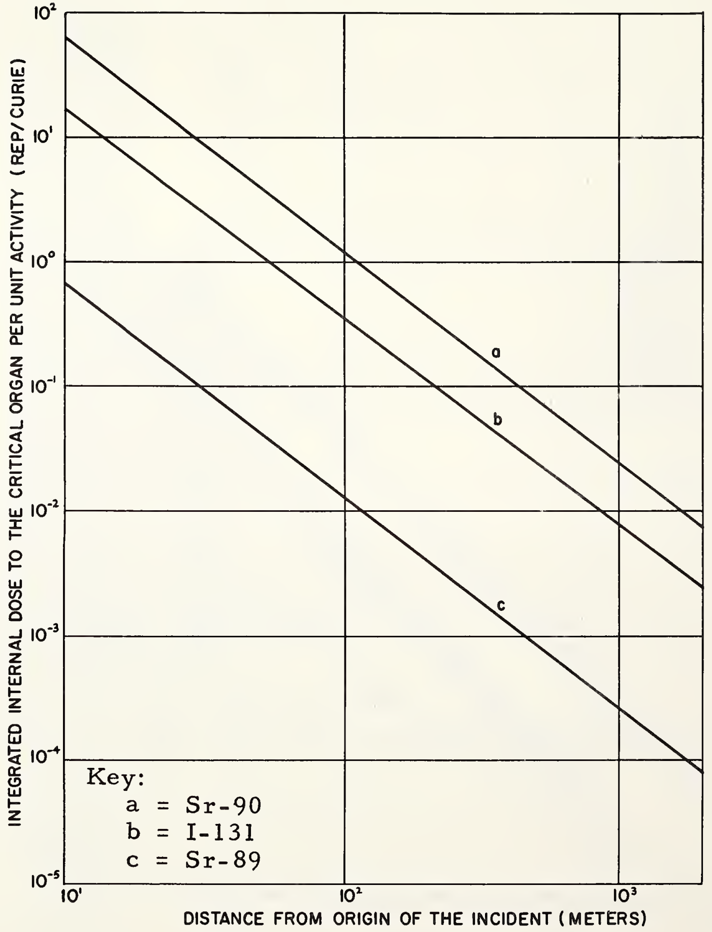


Figure 15. Critical Assembly Data. Integrated Internal Dose from Inhaled Iodine and Strontium Following a Critical Facility Incident

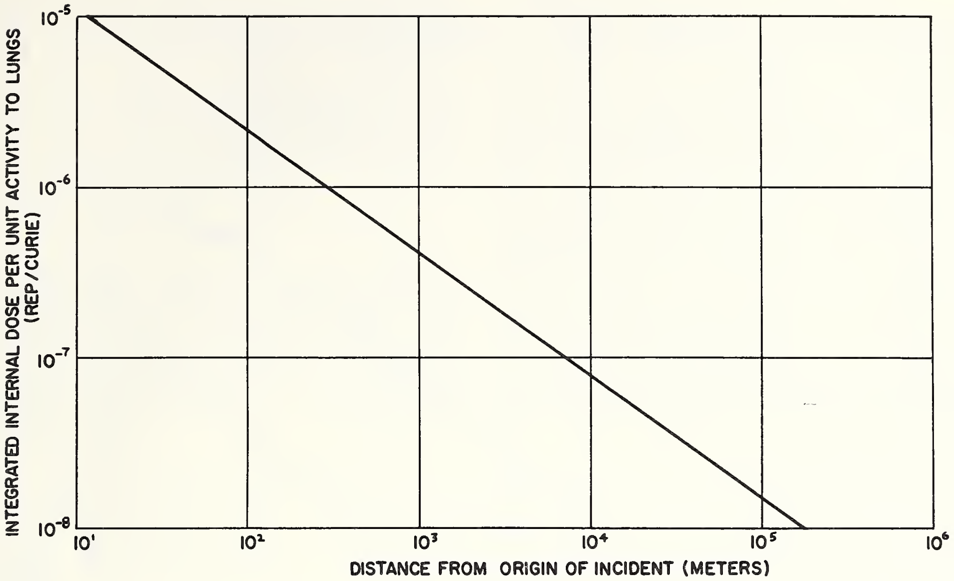


Figure 16. Critical Assembly Data

Integrated Internal Dose to Lungs from the Inhalation of Fission Products Following a Nuclear Incident

obtained would be for the particle size to be large enough to make the gravity fall-out component important, which is not realistic.

Submersion Exposure

In general, the dose to a body from submersion in contaminated water is not significant. In specific instances, however, this exposure may be significant. The dose-rate in rep/week from the submersion of a human body in water with an activity of C (μc/cc) with an average energy per disintegration of $\sum bE$ in mev is $19C\sum bE$. To illustrate, the dose-rate to a submerged body in a concentration of 1 μc/cc with an average energy of 1 mev is 1.9×10^{1} rep/week.

Inhalation Exposure

The dose to critical organs of the body from the inhalation of fission products and Na-24 at a distance of x meters from the origin is presented in Figures 15, 16, and 17 in rep per curie.

Power Reactor Hazard Evaluation

Direct Radiation Exposure

The dose-rates from the fission products contained within a 2-inch steel container are given in Figure 18 as a function of distance from the origin of the incident, 10 seconds after the incident occurred. The dose-rate at a time, t seconds after the incident, can be obtained by multiplying the dose-rate curve presented in Figure 18 by $(0.1t)^{-0.2}$. For example, the dose-rate at a distance 100 meters from the origin 10 seconds after the incident from the direct radiation will be 34 r/hr/Mw through 2 inches of steel. The dose-rate at the same position 1 hour after the incident is reduced by a factor of $(360)^{-0.2}$. Therefore, the dose-rate at 1 hour following the incident will be 10.5 r/hr/Mw.

Fission Products Cloud Exposure

The dose from the instantaneous release of the fission products cloud along the ground and passing through an observer at x meters from the

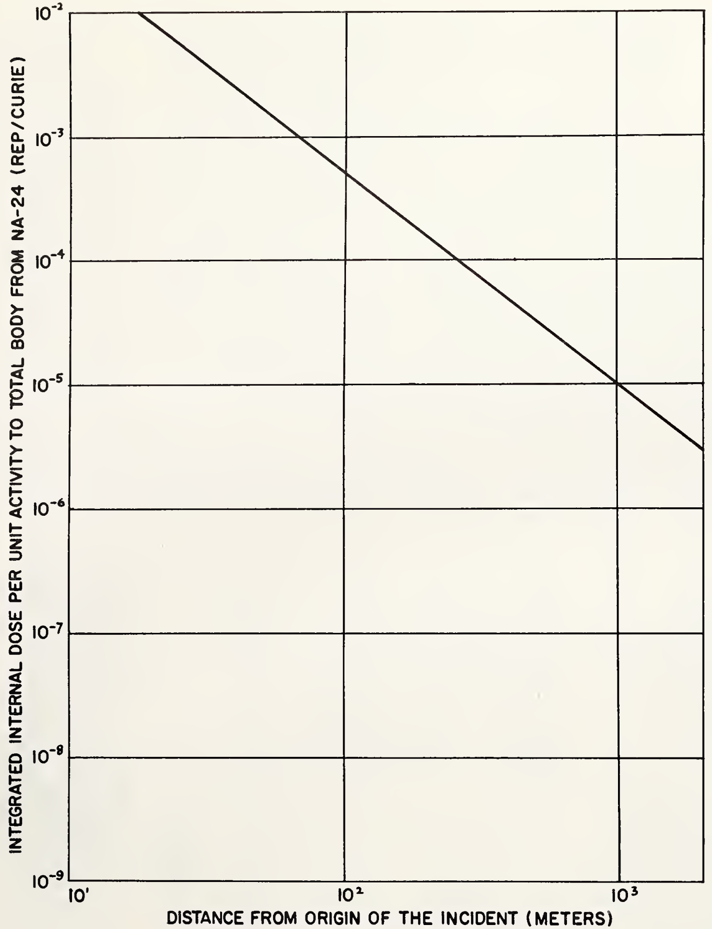


Figure 17. Critical Assembly Data
Integrated Internal Dose to Total Body from the Inhalation of Sodium-24 Following a Nuclear Incident.

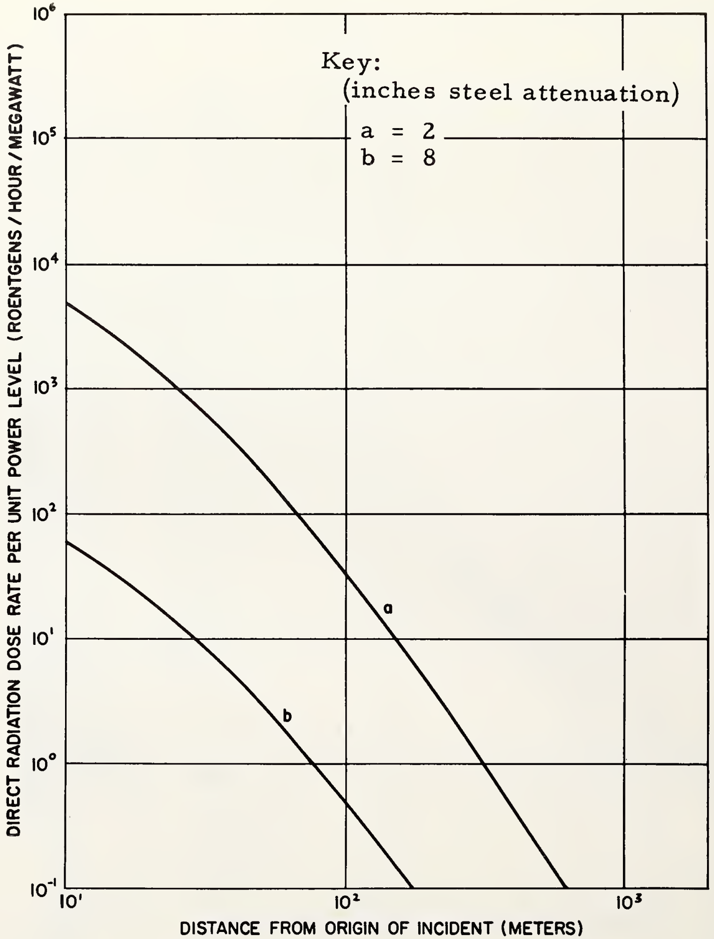


Figure 18. Power Reactor Data
Direct Radiation Dose-Rate per Unit Power Level 10 Seconds after a Nuclear Incident. Assume standard build-up factors, energy attenuation in air, point source and saturated operating time for a power reactor.

origin of the incident is presented in Figure 19 for both lapse and inversion meteorological conditions. The dose from the continuous release of the activity of a period of one hour, the dose at a distance x meters from the origin, is equal to the product of the dose given in Figure 20, and

$$[(\tau \text{ hours})/2]^{-1.2}$$

For example, for a release period of 4 hours, the doses are multiplied by 0.87. For wind velocities other than 1 meter/second, the doses are multiplied by $v^{-0.8}$, where v is in meters/second.

Fall-Out Radiation Exposure

The integrated fall-out dose for periods of 1, 10, and 100 hour exposures are given in Figures 21 and 22. As indicated by these two figures, the fall-out doses are relatively independent of the cloud velocity. These fall-out doses are doses from the maximum fall-out at each position. It is believed that these doses over-estimate the actual doses by factors of 10^1 to 10^2, as previously stated.

Submersion Exposure

The submersion dose is generally very small and may be neglected. The

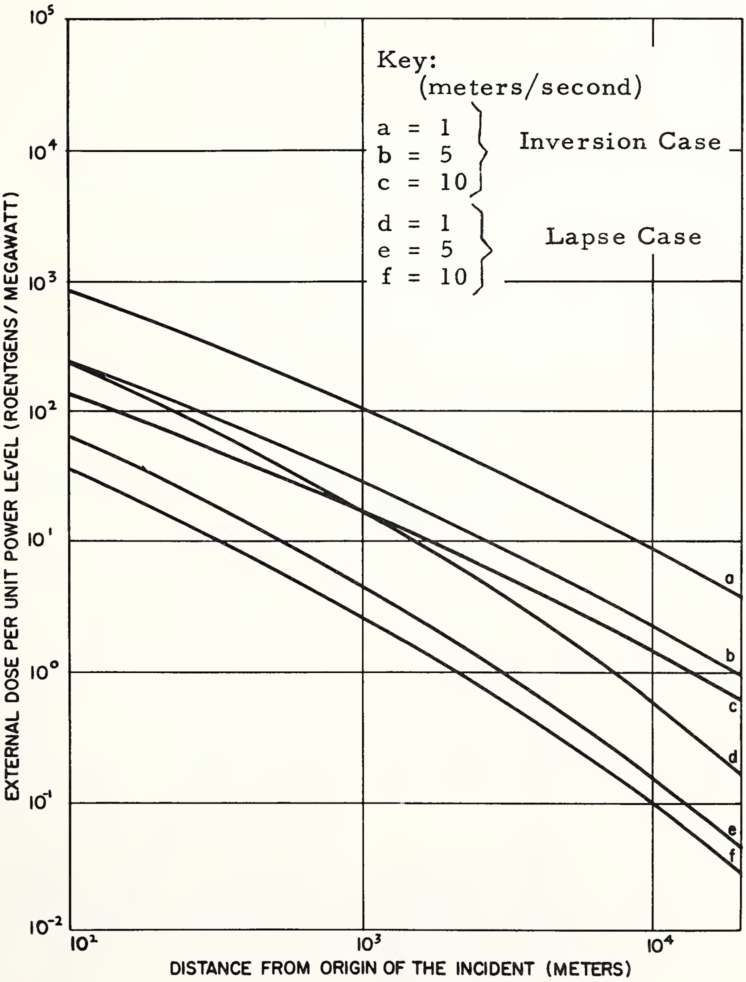


Figure 19. Power Reactor Data
Integrated External Dose from the Passage of a Fission Products Cloud Following an 100% Instantaneous Point Source Emission from a Power Reactor Incident. Assume saturated activity, E = 0.7 mev/disintegration and $\mu = 0.0035\ m^{-1}$.

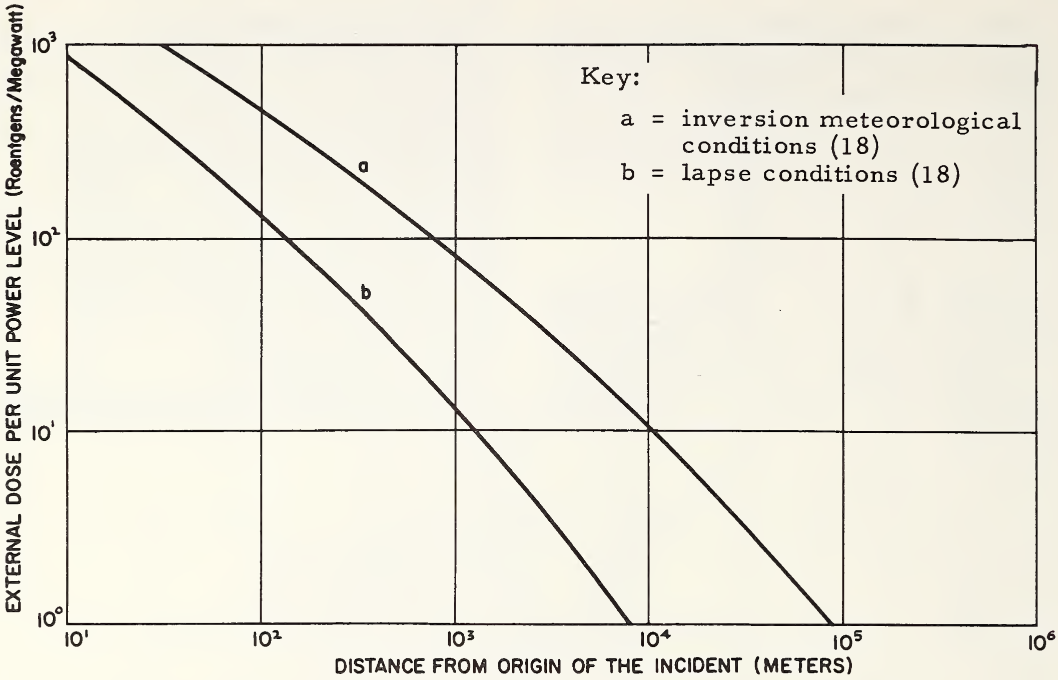


Figure 20. Power Reactor Data
Integrated External Dose from the Passage of a Fission Products Cloud Following a Nuclear Incident. Assume continuous point source emission over 2-hour period, 100% release, saturated activity, wind velocity of 1 meter/second, E = 0.7 mev/disintegration.

formula for computing the dose is the same as given under the corresponding section in the Critical Assembly Hazard Evaluation.

Inhalation Exposure

The dose to the critical organs of the body from the inhalation of the fission products at distances of x meters from the origin are presented in Figures 23, 24, 25 and 26 for operational periods of 100 hours and 8760 hours.

Example of Hazard Evaluation

To illustrate the use of the graphs, a critical assembly incident of one megawatt-sec and a reactor incident following a 100 hour operation at a power level of 1 megawatt will yield the doses and dose-rates, shown in Table 4 (page 204).

Acknowledgments

The author is very grateful for the advice and assistance given by L. L. German and H. Hurwitz, Jr.; the initiation and development of many formulas used in this study by H. Hurwitz, Jr. and L. Tonks; the calculations made and the graphic aids constructed by D. G. Chappell; the fission yields and data supplied by J. R. Stehn and E. F. Clancy; the legal advice and discussions given by A. Gallen; the construction of graphic aids by C. G. Detwiler; the preparation of graphic aids for reproduction by R. H. Miles and R. W. Miles.

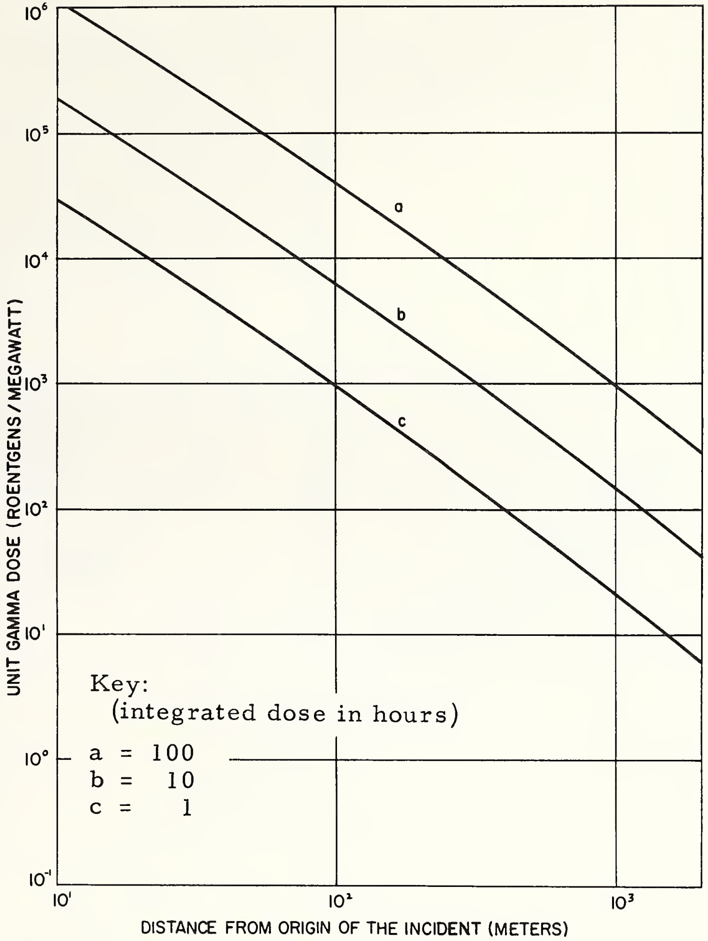


Figure 21. Power Reactor Data

Fall-out Dose. Maximum dose per unit operating power at any distance X meters from origin of the incident; for a release of 100% of the total saturated fission products, under lapse meteorological conditions and a wind velocity of 2.5 meters/second.

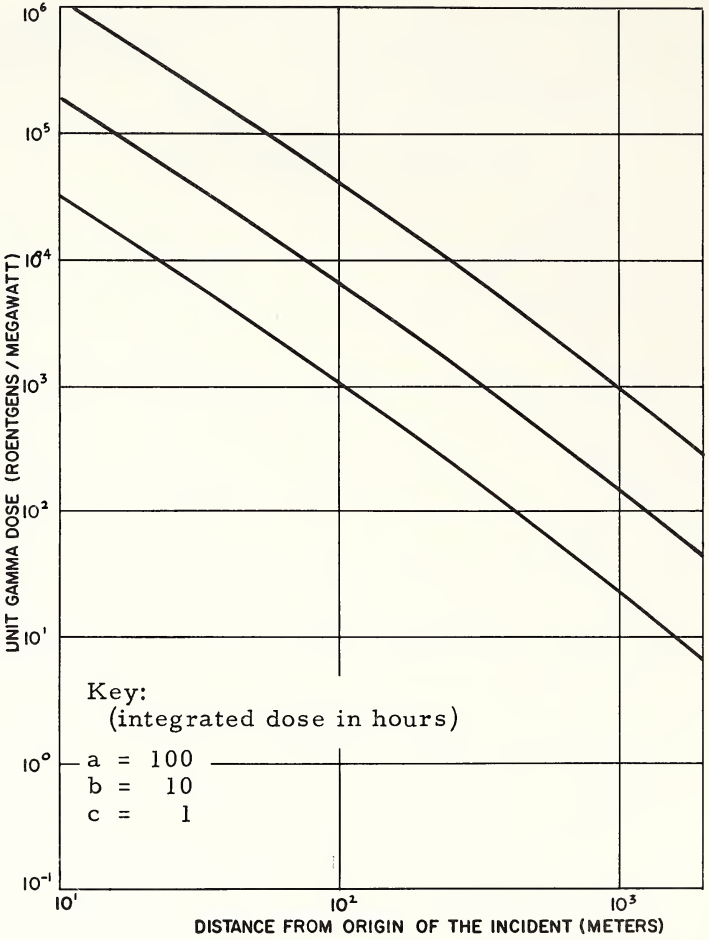


Figure 22. Power Reactor Data

Fall-out Dose. Maximum dose per unit operating power at any distance X meters from origin of the incident; for a release of 100% of the total saturated fission products, under lapse meteorological conditions and a wind velocity of 5 meters/second.

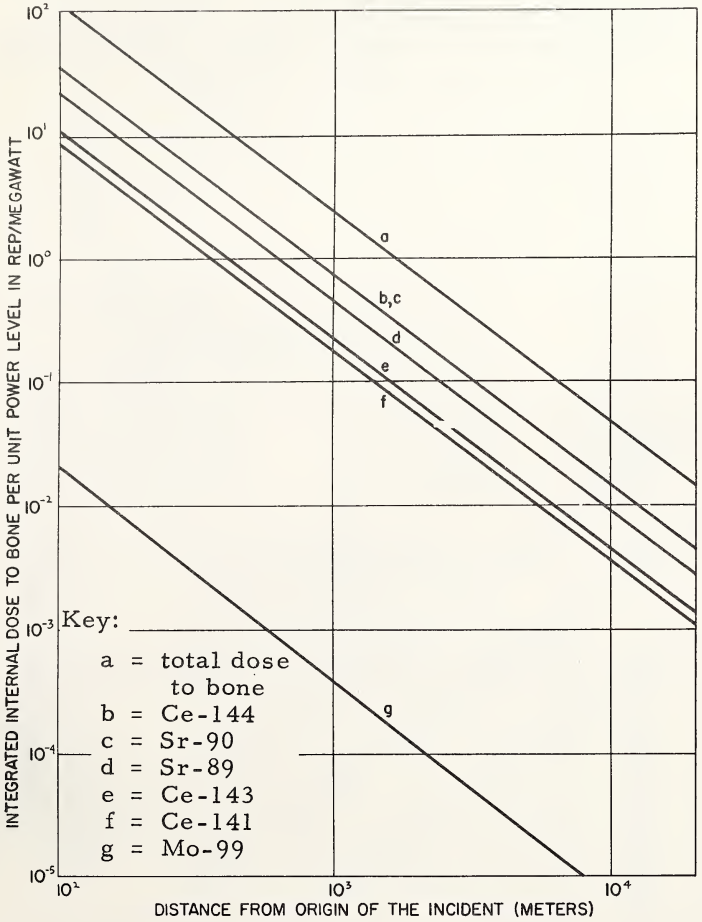


Figure 23. Power Reactor Data
Integrated internal dose to bone from 100% release of activity following 100 hours of operation.

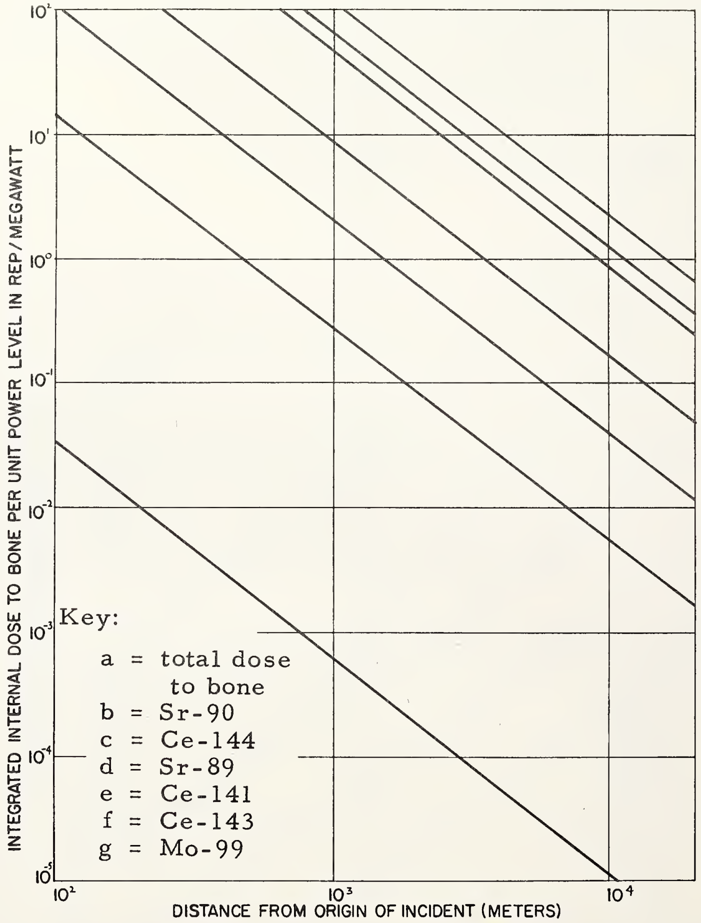


Figure 24. Power Reactor Data
Integrated internal dose to bone from 100% release of activity following one year of operation.

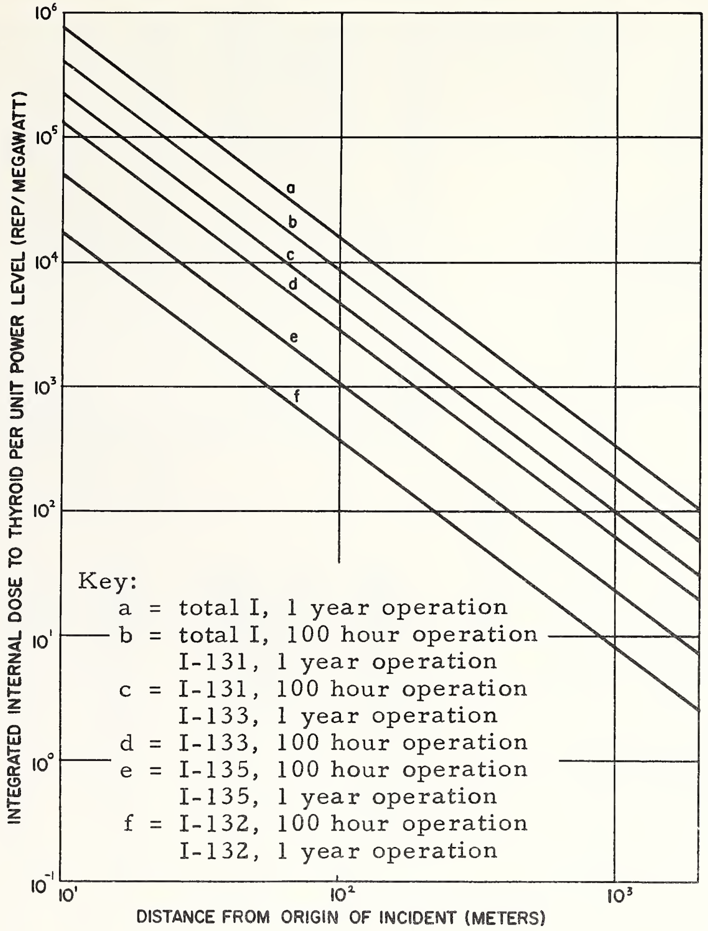
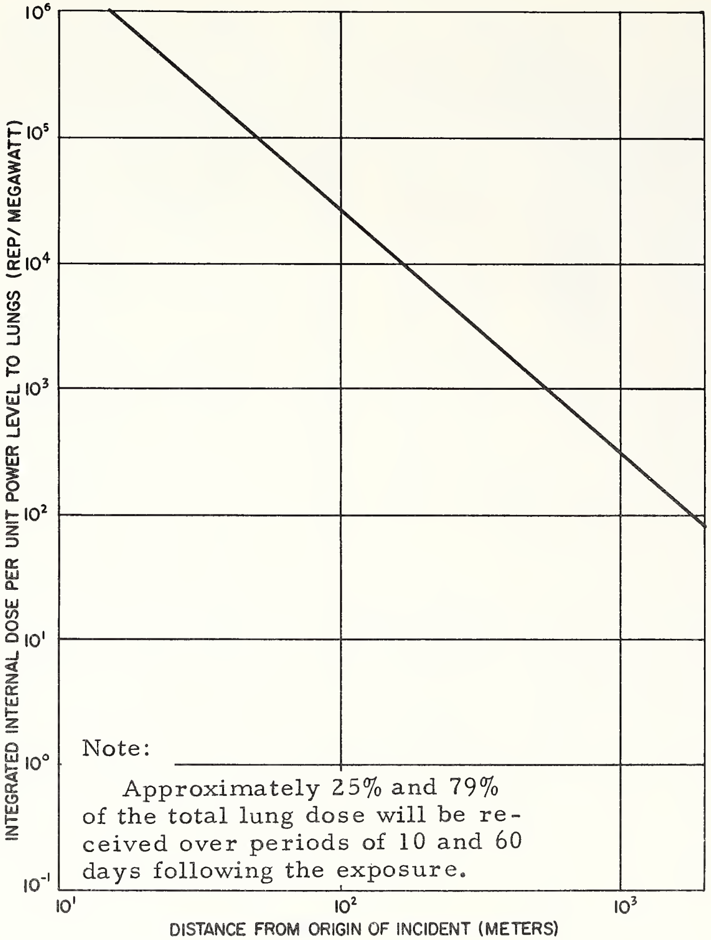


Figure 25. Power Reactor Data
Integrated internal dose to thyroid from 100% release of activity following 100 hours or 1 year operation.



Note:
Approximately 25% and 79% of the total lung dose will be received over periods of 10 and 60 days following the exposure.

Figure 26. Power Reactor Data
Integrated internal dose to lungs from the inhalation of fission products following a power reactor incident.

Table 4. Hazard Evaluation

Radioactivity	Critical Assembly Incident 1 megawatt-sec transient	Reactor Incident 100 hours operation at 1 megawatt
Total Beta	$3\times10^6 t^{-1.2}$ curies	$15.4\times10^6 t^{-0.2}$ curies
Total Gamma	$1.82\times10^6 t^{-1.2}$ equivalent curies	$9.1\times10^6 t^{-0.2}$ equivalent curies
Sr-89	0.057 curies	
Sr-90	0.0001 curies	
I-131 + Te-131	0.025 curies	
External Dose (at 100 meters from origin)		
Direct Radiation	11 r/hr (2" steel)	34 r/hr (2" steel)
F. P. Cloud	0.73 r (instantaneous release)	4.4 r (instantaneous release)
Fall-Out	0.64 r (infinite exposure)	940 r (1 hour exposure)
Internal Dose* (at 100 meters from origin)		
Sr-89	0.75 mrep	22 rep
Sr-90	0.12 mrep	33 rep
I-131	8.8 mrep	3700 rep

*Assumes lapse meteorological conditions with a wind velocity of 5 m/sec.

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SECTION 9

ALLERGIC DISEASE IN INDUSTRY

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This section is included primarily to acquaint the nonmedical reader with some representative industrial medical problems which until now have in many cases been obscurely defined. It has been found that the concept of allergy explains many of these problems. What heretofore have been considered to be purely toxicological reactions have in some instances, after careful evaluation bearing allergic reaction in mind, turned out to be allergic phenomena.

Allergic diseases may affect almost any part of the body and this chapter attempts in a general way to categorize these and to explain them in a rational manner.

These diseases are found in both occupational and nonoccupational pursuits. It is the purpose of this section to indicate wherein industrial materials may act as causative factors. The most easily recognizable allergic symptoms are listed in the adjacent table.

General Symptoms of Allergic Disease

Organ Affected	Description of Symptoms
Skin	A rash, usually of the eczematous type, seen as reddened patches with some oozing, crusting, scaling and swelling. These patches may even at times run together to form larger areas, sometimes large enough to cover the whole face, neck, hands, arms, trunk, chest, etc. For example: contact dermatitis, hives, angioedema and eczema.
Lungs	Cough, tenacious sputum, cyanosis, wheezing, shortness of breath, or even at times complete or almost complete obstruction of breathing; for example: asthma.
Eye	Lachrymation, often with severe itching and swelling of the lids. Occasional photophobia.
Nose	Nasal blockage, watery rhinorrhea, itching nasal passages, sneezing, post nasal discharge.

Complications of Allergic Disease

(1) Sinusitis—complication of long standing nasal allergy. Chronic obstruction of nasal passages causes infection to supervene more frequently. Such infection (sinusitis) may cause disability. Thus the infected sinus while nonoccupational may be a sequela to an industrially caused nasal allergy.

(2) Chronic middle ear disease, the mechanism of which is the same as for sinusitis above.

(3) Asthmatic bronchitis—may result from infection which becomes superimposed upon chronic bronchial asthma. It may become deepseated and long lasting.

(4) Emphysema—a late complication of chronic obstructive lung disease characterized by "barrel shaped" chest, lungs in chronic state of expansion, and dyspnea due to marked

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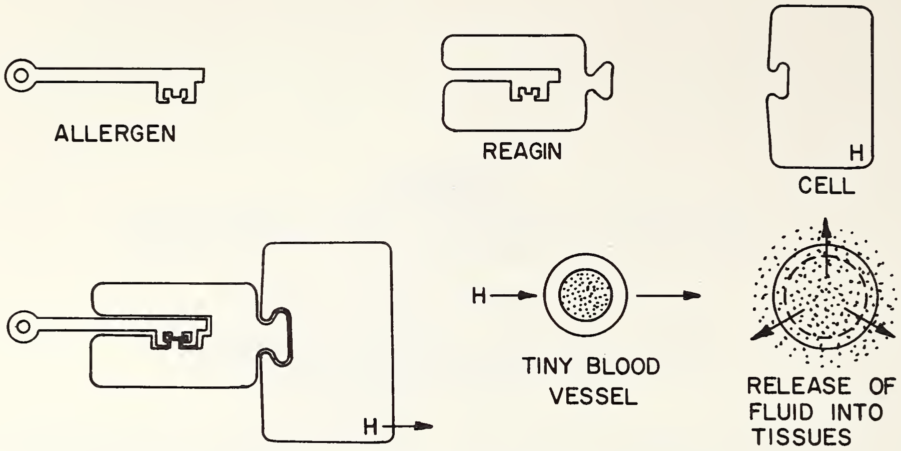

Figure 1. Simplified Allergen Mechanism

loss of elasticity of pulmonary apparatus.

(5) Heart damage—a very late and infrequent sequela of long standing and severe respiratory obstruction.

(6) Eyelid and conjunctival infection—occasional complication due to rubbing the eyes which are affected by an allergic reaction.

(7) Pyodermas—infections in the skin as a result of bacterial implantation superimposed upon any type of allergic skin disease.

The Mechanism of Allergic Reactions

The mechanism by which an allergic reaction takes place is rather complex; but this possibly oversimplified explanation may explain it more easily.

An allergic person, by inheritance, produces *reagins* in the blood stream. These reagins are the body's response to the presence of *allergens* and are specific reactors to specific allergens. The reagin attaches itself to specific organ tissues such as mucous membranes of the nose, conjunctivae, paranasal sinuses, pulmonary membranes and the skin. When the allergen and reagin unite, a substance resembling histamine (or "H" substance) is released into the body fluids. This "H" substance may affect the walls of the tiny blood vessels and/or the smooth muscles of the hollow organs. Increased permeability of blood vessels leading to edema causes hives (urticaria) or angioedema. If the smooth muscle of the hollow organ is excited by the "H" substance spasm follows. This spasm is particularly noted in the bronchial musculature, as in the case of asthma.

In summary (see also Figure 1):

(1) allergen enters the body
(2) specific reagin is produced
(3) allergen and reagin are attached to tissue cell.
(4) "H" substance is liberated
(5) (a) "H" substance acts upon tiny blood vessels with resultant edema; (b) "H" substance acts on smooth muscle with resultant spasm.

Allergy, or more accurately, allergic disease, is presently estimated to affect the lives of from 10 to 30 percent of the population. The concept of allergy is relatively new in medical circles and within the last 25 years many otherwise puzzling ailments have been recognized to be allergic diseases.

Generally, an allergic disease is not fatal, but may be disabling. The materials which cause it are usually quite harmless to the non-allergic individual. In industry the problem of lost time as a result of on-the-job contacts with allergens is a perplexing one, and is complicated by off-the-job contacts over which the industrial hygienist has little or no control.

Probably the most frequent industrial allergic disease is one of the skin, namely, contact dermatitis. This disease may vary from ill defined erythema to edematous, papular, vesicular, and bullous eruptions, depending on the degree of sensitization and concentration of the inciting agent. Such other manifestations as bronchial asthma, "hay fever," chronic sinus diseases, hives, angioedema, eczema, etc., and even migraine headache may at times be precipitated by industrial contact.

Factors Influencing Allergic Disease

(1) Predisposition or Susceptibility. Allergically susceptible persons are usually so by heredity. Statistically 30 to 90 per cent of the offspring of allergic parents may show allergic predisposition.

(2) Exposure

(a) Quantitative. In general it can be said that the more severe the exposure the more severe the symptoms.

(b) Duration. There is usually a lapse between initial exposure and the time at which symptoms become manifest. During this period the person is developing the specific sensitivity. This time varies depending on the type of substance as well as many other factors.

(3) Specificity

(a) Individual. An allergic reaction may be precipitated by one specific substance, i.e., by the wool of sheep but not necessarily of other animals, or by chromium and not necessarily by other metals.

(b) Group. Some allergic people react to groups of allergenic substances which are closely related either biologically (all members of the cucumia or melon group such as cucumber, muskmelon, cantaloupe, etc.) or chemically (the quinones, arsenicals, mercurials, salicylates, etc.).

(4) Summation of Allergenic Effects. The total manifestation of allergic disease is a summation of all the allergic reactions existing at a given time. For example, two or more allergic reactions occurring simultaneously may result in very noticeable symptoms, whereas the effects of any one might escape conscious notice.

(5) Miscellaneous. Emotional upset and other psychosomatic factors may aggravate allergic disease, as may fatigue, toxic states secondary to infection, the use of certain drugs, and the ingestion of alcohol.

Major Classifications and Excitants of Allergic Disease

(1) Contact Allergy. An all inclusive concept covering eruptions resulting from sensitization to agents reaching the skin or mucous membranes externally. It does not include dermatitis from direct irritation due to caustics, heat, etc. It is probably the most common dermatosis of modern life. The skin eruption is generally nonspecific in type; that is, a variety of causes may produce the same clinical reaction. This skin disease may vary from a barely perceptible reddening to edematous, papular, vesicular, or even bullous eruptions. The degree of sensitization and the concentration of the inciting agent or agents largely determine the severity of this skin reaction. Although exposed areas of the body are most commonly involved, any part of the skin or mucous membrane may be affected. Contact dermatitis, though usually of short duration, may persist, at times, for many weeks after the inciting agent has been identified and removed. It is characterized by an eczematoid skin eruption usually limited to exposed areas and is caused by a local allergic type of reaction to specific substances. Examples of such inciting substances are:

- Plant Products
  - Grasses (timothy, etc.)
  - Flowers (primrose, pyrethrum, etc.)
  - Weeds (ragweed, etc.)
  - Trees and their products (jute, hibiscus, acacia, coco bolo, turpentine, etc.)
  - Nuts (walnuts, etc.)
  - Spices (mustard, etc.)
  - Fruits and vegetables (asparagus, oranges, etc.)
- Cosmetics
  - Hair dye
  - Toilet waters
  - Perfumes, etc.
- Animal Products
  - Lanolin
  - Glue
  - Furs, etc.

(continued)

Drugs
- Ammoniated mercury
- Arsphenamine
- Procaine, etc.

Chemicals
- Arsenic compounds
- Chromium compounds
- Quinones, etc.

Note: Table 1 will assist in establishing the relationship between the occupation and the contactants above listed.

(2) Respiratory Allergy. This is characterized by coughing, wheezing, sneezing, excess mucous production resulting in obstruction of the nasal and pulmonary airway and precipitation of asthma by edema of the mucous membranes and/or spasm of the smooth muscles of the bronchioles. Examples of this are bronchial asthma and nasal allergy caused by a systemic allergic reaction to inhaled and/or ingested allergenic substances. Examples of such substances are:

Plant Products
- Pollens of grasses, ragweed, trees, etc.
- Spores of mold (alternaria, hormodendrum, etc.)
- Trees and their products (sawdust, jute, etc.)
- Nuts and seeds (cotton-seed, flaxseed, etc.)
- Spices (mustard, etc.)

Cosmetics
- Perfumes, etc.

Animal Products
- Animal furs
- Danders, etc.

Drugs
- Aspirin, salicylates, etc.

Note: Table 1 will assist in establishing the relationship between the occupation and the substances listed above.

(3) Skin Allergy. This is characterized by urticaria, angioedema and atopic eczema caused by a systemic allergic reaction to inhaled and/or ingested allergenic substances. Examples of such substances are:

Plant Products
- Pollens of grasses, ragweed, trees, etc.
- Mold products (mushroom, cheese, penicillin, etc.)
- Trees and their products (hibiscus, turpentine, etc.)
- Nuts and seeds (walnut, flaxseed, etc.)
- Spices, and flavorings (mustard, etc.)

Cosmetics
- Orris root, perfumes, etc.

Animal Products
- Wool
- Animal danders, etc.

Drugs
- Aspirin and salicylates
- Penicillin, etc.

Note: Table 1 will assist in establishing the relationship between the occupation and the substances listed above.

Differential Diagnosis

Contact allergy should be differentiated from other types of skin diseases with which it is frequently confused.

(1) Dermatitis from primary irritants is caused by the direct action of a chemical substance on the skin at the point of contact. Such a substance may dissolve or emulsify the fat in the skin, precipitate the proteins, as in a tanning action, or it may cause a chemical oxidation or reduction of the outer skin. It may dehydrate or dissolve the keratin or outer layer or cause a keratogenic or thickening action. Primary irritation produces a skin inflammation resembling a burn; this will occur almost invariably when such substances come in contact with the skin. A common example of such a substance is kerosene; its effects on the skin vary from the diffuse redness of a first degree sunburn to the blistering of a second degree burn. Susceptibility is greatest in thin-skinned blondes, but almost anyone will react to some degree.

(2) Oil folliculitis is not an allergic reaction but is often confused with allergic disease. It is an inflammation and infection localized to the hair follicle and is caused by oil. Severe cases are often called "oil boils." This skin disease results from continued contact of the hairy skin with oil which carries bacteria down into the follicles causing an infection. Dark, oily-skinned persons are more likely to develop such an irritation than fair-skinned persons. Of utmost importance here is personal hygiene;

Table 1. Occupations, Symptoms, and Likely Sensitizers

Key: R - Respiratory Symptoms—Asthma and Nasal Allergy (hay fever)
S - Skin Symptoms—Eczema and Hives, Angioedema
C - Contact Dermatitis

Occupation	Symptoms	Sensitizers—Allergens
Agricultural	R, S, C	Animal, plant and mold products. Insecticides, chemicals, drugs, solvents, detergents, etc.
Airplane workers	C	"Dope" solvents, paints, woods, glues, electroplating compounds
Asphalt and pitch workers	C	Pitch, tars and petroleum products
Autotyper	C	Bichromate form of chromium
Bakers and millers	R, S, C	Flours, conditioners, bleaches, flavoring extracts, vegetable dyes, sugars, eggs, chocolate, mold, etc.
Barbers	C	Cosmetics, depilatories, hair dyes, hair preparations containing mercury, quinine, resorcin and sulfur
Brewery workers	R, S, C	Barley, grains, hops, malt, yeast, mold, glues, paper products, inks, detergents, etc.
Bricklayers, masons	C	Paints and stains
Bronzers	C	Arsenic and metallic salts
Burnishers	C	Mercurials
Butchers	R, S, C (Hog Itch)	Animal hairs and danders, intestinal contents, molds, detergents, insecticides
Cabinet makers and carpenters	R, S, C	Sawdusts, resins, glues, lacquers, solvents, varnish, thinners
Candy makers	R, S, C	Nuts, spices, flavorings, fruits, sugars, dyes, vegetable colorings
Canners of fruits and vegetables	C	Fruits, vegetables, juices
Cattlemen	R, S, C	Cottonseed, feeds, grains, hair and danders, molds, pollens, detergents, cleansers, etc.
Chemists	C	Irritants and allergenic substances in common use in the laboratory
Circus workers	R, S, C	Animal hairs and danders, disinfecting, deodorizing and cleansing chemicals, dyes, fabrics, foods, grains, pollens, molds, sawdust

Table 1. Occupations, Symptoms, and Likely Sensitizers (continued)

Occupation	Symptoms	Sensitizers—Allergens
Compositors	C	Chromium compounds
Cooks	R, S, C	Flours, fruits, vegetables, flavorings, vegetable dyes, spices, soaps, detergents, insecticides, mold
Dentists and dental technicians	C	Antibiotics such as streptomycin, penicillin, etc., iodoform, "Novocaine", various 'caine drugs, mercury amalgam
Dye workers	C	Dyes of all sorts and intermediates
Electroplaters	C	Chromium compounds, cyanides, copper compounds
Electrotypers	C	Copper compounds, chromium compounds
Explosive manufacturers	C	Ammonium nitrate, DNT, mercury fulminate, "Hexite," picric acid, picrates, tetryl, TNT, p-phenylenediamine
Exterminators	R, S, C	Arsenic compounds, fluorides, formalin, mercury compounds, pyrethrum, cereal grains, DDT, "Lethane," paradichlorbenzene, rotenone
Felt workers	R, S, C	Bichromates, hair and dander, mercury salts, sizings
Foresters	R, S, C	Insecticide sprays, "poisonous" shrubs, pollens, sawdusts, molds
Fruit and vegetable handlers	R, S, C	Dyes, fruit colorings, fruits, vegetables, glues, insecticides, mold, oils, paper, waxes, woods
Fur cleaners	R, S, C	Cleansers, dusts, dyes, fabrics, hair, danders
Furniture workers	R, S, C	Dusts, fabrics, glue, lacquers, metals, mold, paint, plastics, sawdusts, woods, kapok
Furriers	R, S, C	Aniline dye, arsenic compounds, p-amidophenol, p-phenylenediamine
Garage workers	C	Chromium compounds, copper salts, detergents, oils, rubber, soaps
Gardeners	R, S, C	Arsenic compounds, fertilizers, insecticides, mold, plants, pollens, and substances from trees and plants
Grocers	R, S, C	Sugar, flours, flavorings, spices, fruits, vegetables, burlap, glue
Hair dressers and beauticians	C	Ammonium thioglycolate, hair dyes, wave set solutions, cosmetics, perfumes, resins

Table 1. Occupations, Symptoms, and Likely Sensitizers (continued)

Occupation	Symptoms	Sensitizers—Allergens
Insecticide workers	R, S, C	Insecticides, 'pyrethrum, DDT
Interior decorators	R, S, C	House dusts, dyes, colorings, paints, lacquers, resins, fabrics
Iron and steel workers	C	Chromium compounds, "pickling" chemicals, "case hardeners," quenching oils, mold makers' sand
Jewelers	C	Chromium salts, cyanides, nickel salts
Leather workers	C	Amido-azo-toluene hydrochloride, arsenic, sodium sulfide, bismark brown, dyes, nigrosene, vegetable and chemical tanning agents, bichromates, sumac, tannins
Machinists	C	Oils, cutting oils (espec.), soaps, chromium compounds
Milliners	R, S, C	Dyes, arsenic, feathers, wool, felts, hair, dusts, glues, fabrics
Nurses	C	Mercury bichloride, 'caine drugs, formalin, detergents, soaps, medicated oils and alcohols, streptomycin, penicillin, antiseptics
Painters	C	Aniline dyes, linseed oil, paint removers, pigments, dyes, arsenic compounds, thinners, tar distillates, turpentine, varnish removers, bichromates
Paper makers	C	Dyes, glue, resins, wood pulp, mucilage, bleaching solutions, digesting solutions, paper dust
Pharmacists	C	Chemicals, drugs, dyes, coloring, glue, solvents, oils, waxes, etc.
Photoengravers and lithographers	C	Bichromates, photodevelopers, inks, dyes
Photographers	C	Chromium compounds, hydroquinones, metol, mercury salts, silver and platinum salts, pyrogallol, sulfides, p-phenylenediamine
Photogravure workers	C	p-nitranilin red, inks, dyes
Photostat workers	C	Chromium compounds
Piano workers	C	Aniline dyes, arsenic in felts
Plywood workers	C	Casein, glues (espec. those made from the synthetic resins), woods and wood dusts

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Table 1. Occupations, Symptoms, and Likely Sensitizers (continued)

Occupation	Symptoms	Sensitizers—Allergens
Polishers of metals	C	Bichromates, turpentine
Preserve packers	C	Fruits and vegetables, glues, inks, colorings
Printers	C	Inks, soaps, dyes
Rayon manufacturers	C	Bleaches, coning oils
Resin manufacturers	C	Formaldehyde, hexamethylenetetramine, monomers of polymerized resins, phenol, urea
Restaurant workers	C	Fruits, vegetables, juices, flavorings, extracts, spices, colorings, flours, soaps, mold, insecticides
Road workers	R, S, C	Asphalt, tar, "poison" plants, pollens of plants in the vicinity
Soap manufacturers	C	Aromatics added to soaps, soap, detergents, volatile oils, colorings
Solderers	C	Chromium compounds
Varnishers and lacquerers	C	Resins, thinners, dyes, pigments, lacquers

the most effective prevention lies in adequate washing facilities.

(3) Dermatophytosis is commonly called "athlete's foot." This fungus-type disease can also cause a skin eruption on the hands, called dermatophytid. The dermatophytid, or "id" reaction, can be very easily confused with contact dermatitis. In many cases the reaction on the hands opens the way for further difficulty due to contact with chemicals or to other substances acting as sensitizers.

Things for the Safety Director to Keep in Mind with Regard to Allergic Disease in Industry

(1) Should an employee present allergic symptoms outside his occupation as well as while at work, the probable extra-occupational allergenic exposures must be carefully evaluated.

(2) The more frequent allergy problem which has to be faced will probably be contact dermatitis. In this regard it should be remembered that contact dermatitis will be found most often at the site of contact with the offending substance. A rubber face mask may produce a dermatitis of the face; a plastic handle may produce dermatitis of the hand. It should also be remembered that in some instances the allergens cause dermatitis only when they become dissolved in perspiration or other body fluids. A dust which is suspended in the air and permeates the clothing might cause dermatitis of the armpits or the groin only because there is sufficient moisture from perspiration to dissolve the dust and carry it through the clothing and into the skin.

Friction from clothing may also be a factor in rubbing the allergen into the skin at the point of contact. Thus contact dermatitis may develop more easily under the waist band or under the collar or cuffs.

(3) As to the use of antihistamines, it must be remembered that they do not relieve the disease. In order to relieve the disease they would have to prevent the reaction between the allergen and the reagin, which produces the "H" substance. All the antihistaminics can do is prevent the "H" substance from reacting with the small blood vessels or smooth muscle which results in the allergic manifestation. Now, once the body reacts to an allergen by manufacturing a reagin to the specific allergen an equilibrium is established. The more the body is in contact with that allergen, the more reagin it is going to produce. It follows therefore that after exposure to a massive dose of allergen, so much reagin is produced that a great deal of "H" substance is formed and a tremendous amount of antihistaminic would be necessary merely to relieve the symptoms.

Antihistaminic drugs have beneficial reactions, but they may also have toxic reactions. It may become necessary for the patient to take so much antihistiminic to relieve the symptoms that he may suffer more from the toxic reaction to the drug than he would have suffered from the allergic symptoms. Another general disadvantage of antihistaminic drugs is their sedative effect. An individual who is under the influence of these drugs may become sleepy or sluggish to the extent that his coordination becomes affected and he is unable to perform his normal duties at work or even to drive his car. It is important that the amount of antihistaminic which an individual takes is carefully controlled by a physician.

Furthermore, he may depend upon the antihistaminic drug to control the allergic symptoms and forget to do something about the cause of the trouble. Only by searching out and identifying the exciting agent can proper measures be taken either to remove it from contact with the worker or to protect him from it. Palliative measures are therefore really justified only if at the same time a concerted effort is being made to deal with the causal agent.

(4) With regard to protective measures for personnel against the effects of allergens, they are precisely the same as those described in Section 3 for protection against the effects of industrial poisons.

(5) While the primary job of the Safety Director is related to the control of environmental allergenic factors he should not overlook the fact that emotional tensions can contribute to allergic reactions. He may help the worker to resolve his emotional tensions, either by suggesting medical aid or discussing the work problem if that is a cause, etc.

(6) The laws of various states differ as to just what constitutes an "allergic disease" in industry. It is recommended that the law be carefully investigated before a case decision is made. Some states require that trauma be present at the time that the material or substance in question was first introduced into the skin before a "resultant allergic dermatitis" can be legally declared. In other states this trauma is not required. There are various interpretations as to specific cause and aggravation, and in most states the law has been very carefully worded to include all of the usual circumstances. It is not the intention of the writer to enter into any legal discussion regarding an industry's liability in any of the aforementioned circumstances. It is only recommended that those substances which seem likely to cause trouble be carefully watched, and either avoided or handled in such a way that a minimum of disability results.

(7) In industries in which allergic disease is prevalent (see Table 1), stress should be laid during the preplacement physical examination on the history of allergic disease in the person and in his family. During this examination the physician has the opportunity to prevent the development of a large number of chronically allergic patients. If a prospective employee has hay fever, asthma or allergic eczema or if he is known to have hives or angioedema at various times and under specific circumstances, it is better to place him in a job which will be as free from allergens as possible.

Emergency Treatment

A physician called to an emergency room to treat the victim of a severe allergic reaction should have available various drugs, medications and materials. Time may be precious. One of the more important things is an oxygen tank, equipped with the proper valves and gages to deliver oxygen to a patient either by mask, funnel or the like. It is also suggested that hypodermic syringes and needles be kept available in a sterile condition in case the physician needs them. Table 2 lists the materials which should be kept available in the emergency room. None of these materials are expensive and yet they can be lifesaving when they are at hand and can be used by the physician in charge. It should be stressed that the dosage, the technique of administration and the frequency of administration, as well as the decision when to use any of the procedures should be left solely to the discretion of a physician.

Criteria for the Diagnosis of Occupational Dermatoses*

(1) An occupational dermatosis is one in which the role of an occupational causal factor has (at some previous time) been established beyond reasonable doubt.

(2) The person has been working in contact with an agent known to have produced similar changes in the skin.

(3) The time relationship between exposure to the agent and the onset of the dermatosis is correct for that particular agent and that particular abnormality of the skin.

(4) The site of the onset of the cutaneous disease and the site of maximum involvement are consistent with the site of maximum exposure.

(5) The lesions present are consistent with those known to have followed the reputed exposure or trauma.

(6) The person is employed in an occupation in which similar cases have previously occurred.

(7) Some of the person's fellow workers using the same agent are known by the examiner to have similar manifestations.

(8) So far as the examiner can ascertain, there has been no exposure outside of occupation that can be implicated.

(9) If the diagnosis is dermatitis, the following items are important:

(a) Attacks after exposure to an agent, followed by improvement and clearing after cessation of exposure, constitute convincing evidence of the occupational factor as a cause.

(b) The results of patch tests performed and interpreted by competent medical personnel corroborate the history and examination in the majority of cases.

Common Allergens

Table 3 lists the substances which are among the more frequent causes of allergic diseases. These are arranged whenever possible according to a general classification—"Fruits," "Furs," "Waxes," etc. This does not mean that all the materials have the same ability to cause allergic diseases, but it will allow for a more rapid survey of the contactants. The column "Danger of Sensitization by Testing" has been included because, even though it is not a frequent phenomenon, it is an extremely important one and should be avoided if possible.

Allergenic Potential

It has been noted that allergenic materials are a cause of allergic disease. However, this should be further qualified. The allergenicity of all substances is not the same. Some materials, such as poison ivy, buckwheat, p-phenylenediamine, cottonseed, castor bean dust, chocolate, fish glue, wintergreen, are very powerful allergens. These are said to have a high allergenic potential. Extremely small amounts of these allergens acting over a relatively short time are found to produce severe symptoms in the allergic person. Conversely, if an allergen in large amounts, acting over a long

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*These criteria with the exception of a few words are copied verbatim from "Industrial Dermatoses, A Report by the Committee on Industrial Dermatoses of the Section on Dermatology and Syphilology of the American Medical Association," J.A.M.A. 118:613, 1942.

Table 2. Suggested Materials for Emergency Treatment

Drug or Apparatus	Form and/or Concentration	Purpose
Oxygen tank with proper valves and gages	100% medical oxygen	To supply oxygen to the asthmatic patient who is suffering from oxygen lack
Oxygen mask	Rebreathing type	To administer oxygen to patient, better than a funnel or tube
Hypodermic syringes (sterile)	1, 2, 10, and 20 cc	To be available to physician if needed in an emergency
Hypodermic needles (sterile)	20 gage 1 and 1½ in.; 25 gage ⅜ in.	To be available to physician if needed in an emergency
Epinephrine	1-1000 aqueous 30 cc rubber capped vial	Injected subcutaneously for rapid relief of asthma and hives
Epinephrine	1-100 in oil 2 cc glass vial	Injected intramuscularly for prolonged relief of asthma and hives
Aminophyllin	3¾ grains 2 cc glass vial	Injected intramuscularly for relief of asthma
Aminophyllin	7½ grains 20 cc glass vial	Injected intravenously (slowly) for relief of asthma
"Demerol"	30 cc rubber capped vial	Injected intramuscularly for the relief of severe apprehension in patient with asthma. Use caution and small doses.
Antihistaminic	Injectable	Injected for severe hives in emergency
Cortisone	Injectable	To be injected intramuscularly for severe allergic disease
ACTH	Injectable	To be injected intramuscularly for severe allergic disease
Calcium salts	Glass vials	To be injected either intramuscularly or intravenously for emergency treatment of severe hives
Sodium iodide	10% 10 cc glass vial	Administered intravenously for the liquefaction of pulmonary mucus in asthma
Intravenous infusion set-up	Sterile and ready to use 1000 cc flasks of water, glucose, saline, etc.	Given by intravenous route for emergency treatment of asthma. Also used as vehicle to administer aminophyllin, sodium iodide, etc., by intravenous route

Table 2. Suggested Materials for Emergency Treatment (continued)

Drug or Apparatus	Form and/or Concentration	Purpose
"Isuprel" or "Aludrine"	Sublingual tablets	To be kept under the tongue until completely dissolved acting in same way as epinephrine. This method is very useful.
Nebulizer	"Vaponefrin" or DeVilbis #40	May be used as a rapid means of bringing relief in asthma. May use "Vaponefrin," "Aerolone," "Isuprel," or epinephrine 1-100

period of time, produces only slight symptoms, then these substances are said to have a low allergenic potential. Examples of low potential materials are boric acid, rice dust and tea. A material which in moderate amounts, acting over a moderate period of time, causes only moderate symptoms is said to have a moderate allergenic potential. Most substances are in this class.

Testing

The Patch Test. This test is used for determination of the offending agent in contact dermatitis. It is performed by placing the appropriate substance on the cleansed skin, and covering it with a small square of cellophane held down with a strip of adhesive or cellulose tape. The name of the material used, or an identifying number should be written on the tape for later identification. The reason for the cellophane is twofold. It prevents the solution from leaking through the tape and aids in the final reading. If the worker is sensitive to the adhesive he will have a zone of redness with a clear zone under the cellophane. If he is senistive to the substance, as well as to the tape, he will usually have an outer red area, a clear space and an inner reaction.

The actual testing should be done as close to the site of the rash as is practical. If the rash is on the face, it is best to make the test on the neck or back; if it is on the hands, it is best to test on the arm. In some cases several sites may be used successively in order to demonstrate the suspected sensitivity.

The length of time of contact with the test material is important. In some cases a reaction occurs within minutes to a few hours. If so, the patch should be removed and the substance washed off. If no reaction takes place in 24 to 48 hours, it may be necessary in some cases to allow the test to stay in place up to 96 hours.

The patch test is read by recording the amount of redness, vesicle (blister) formation, or more severe inflammatory reactions. If there is only slight localized redness at the point of test, then a 1+ reaction is recorded; if there is marked redness and inflammation and a large amount of blister formation, then it is read as a 4+ reaction. Gradations between these are 2+ or 3+. Of course, if no reaction takes place it is recorded as negative.

The Intracutaneous Test. The intracutaneous test is made by injecting a tiny amount of the properly extracted, sterilized, diluted and standardized material into the outer layers of the skin with a hypodermic syringe and fine needle. The test is read in 10 to 15 minutes as a 1+ to 4+ reaction depending upon the amount of wheal or mosquito-bite-like reaction. A 4+ reaction is noted as a large irregular raised welt with surrounding redness.

Table 3. Common Allergens, Their Effects and Methods of Testing

Key to Abbreviations

Symptoms

C - Contact Dermatitis
R - Respiratory: Nasal, Pulmonary
S - Skin: Hives, Eczema

Type of Test

P - Patch Test
I. C. - Intracutaneous (or Scratch Test)

Vehicle

Alc - Alcohol
Aq - Aqueous
Acet - Acetone
Petr - Petrolatum

Danger of Sensitization

Negl - Negligible
Slt - Slight
Mod - Moderate
Var - Variable
Mkd - Marked

Allergenic Potential

Mod - Moderate
Mkd - Marked
Slt - Slight
Var - Variable
P. I. - Primary Irritant

Type of Action

Cont. - Contact
Inh - Inhalation

The concentration of the test material for scratch or intracutaneous testing is left to the attending physician.

Substance	Symptoms	Type of Test	Concentration or % for Testing	Vehicle	Danger of Sensitization by Testing	Allergenic Potential	Action: Contact, Inhalation
Adhesive plaster	C	P	as is	--	Negl	Low-Mod	Cont
Almond oil	C	P	100%	--	Negl	Mod	Cont
Alum	C	P	10%	Aq.	Negl	Low	Cont
Ammoniated mercury	C	P	5%	Petr	Negl	Mod	Cont
Ammonium fluoride	C	P	1%	Aq.	Slt	Mod	Cont
Auto polishes	C	P	10%	Aq	Slt to Mod	Mod	Cont
Barley	R, S	I.C.	--	--	Negl	Mod	Inh
Bleaching powders	C	P	10%	Aq	Slt to Mod	Mod	Cont
Blueing	C	P	as is	--	Negl	Low	Cont
Boric acid	C	P	50%	Petr	Negl	Low	Cont
Buckwheat	R, S	I. C.	--	--	Negl	Mkd	Inh
"Butesin" picrate	C	P	1%	Alc	Negl	Mod	Cont
Casein	C	P	as is	--	Negl	Mod	Cont
	R, S	I. C.			Negl	Mod	Inh

Table 3. Common Allergens, Their Effects and Methods of Testing (cont.)

Substance	Symptoms	Type of Test	Concentration or % for Testing	Vehicle	Danger of Sensitization by Testing	Allergenic Potential	Action: Contact, Inhalation
Castor bean (dust)	R, S	I. C. (GREAT CAUTION ADVISED)			--	Very Mkd	Inh
Cereal grains	C	P	as is	--	Negl	Slt to Mod	Cont
	R, S	I. C.			Negl	Mod	Inh
Chrysanthemum	C	P	50-100%	Aq	Slt	Mod	Cont
	R, S	I. C.			Slt	Mkd	Inh
Cocoa	C	P	100%	--	Negl	Mkd	Cont
	R, S	I. C.			Negl	Mkd	Inh
Copper sulfate	C	P	1-5%	Aq	Negl	Mod	Cont
Corn	C	P	as is		Negl	Mod	Cont
	R, S	I. C.			Negl	Mod	Inh
Cosmetics	C	P	100%		Negl	Mod	Cont
	R, S	I. C.			Negl	Mkd	Inh
Cottonseed	R, S	I. C. (Use Caution)			Negl	Very Mkd	Inh
Crayons	C	P	50-100%	Petr	Negl	Low	Cont
Daffodil	C	P	leaf or bulb		Negl	Low	Cont
Deodorants	C	P	50-100%	Aq	Negl	Low	Cont
Egg White	C	P	50-100%	Aq	Negl	Mod	Cont
	R, S	I. C.			Negl	Mkd	Inh
Feathers	C	P	as is		Negl	Mod	Cont
	R, S	I. C.			Negl	Mod	Inh
Fish	C	P	Var	Aq	Negl	Mod-Mkd	Cont
	R, S	I. C. (Use Caution)			Negl	Mod-Mkd	Inh
Formaldehyde	C	P	2%	Aq	Negl	Mod	Cont
Flavoring oils	C	P	2%	Alc	Negl	Slt-Mod	Cont
Flaxseed	C	P	as is		Negl	Mod	Cont
	R, S	I. C. (Use Caution)			Negl	Mkd	Inh
Floor Wax	C	P	10%	Petr	Var	Var	Cont
Flour	C	P	as is		Negl	Var	Cont
	R, C	I. C. (Use Caution)			Negl	Var	Inh
Flowers	C	P	as is		Var	Var	Cont
	R, S	I. C.			Var	Var	Inh
Fruits	C	P	50-100%	Aq	Negl but some Slt	Slt to Mkd	Cont

Table 3. Common Allergens, Their Effects and Methods of Testing (cont.)

Substance	Symptoms	Type of Test	Concentration or % for Testing	Vehicle	Danger of Sensitization by Testing	Allergenic Potential	Action: Contact, Inhalation
Furs	C R, S	P I. C.	as is		Negl Negl	Mod Mod	Cont Inh
Glue	C R, S	P (Dangerous - Use Great Caution)	10-50%	Aq	Negl	Mkd Mkd	Cont Inh
Glycerine	C	P	as is		Negl	Slt	Cont
Green soap	C	P	1-5%	Aq	Negl	Slt	Cont
Hair - all kinds	C R, S	P I. C.	as is	Aq	Negl Negl	Mod Mod	Cont Inh
Hair dyes	C	P	10-100%	Aq	Var & Undetermined	Slt to Mkd	Cont
House dust	C R, S	P I. C.	as is		Negl Negl	Slt Mod	Cont Inh
Hops	C R, S	P I. C.	as is		Negl Negl	Mod Low	Cont Inh
Inks	C R, S	P I. C.	10-100%	Aq	Negl-Slt Negl	Slt-Mod Slt-Mod	Cont Inh
Iodoform	C	P	25%	Petr	Negl	Slt	Cont
Juniper oil	C	P	1%	Alc	Negl	Slt	Cont
Kapok	R, S	I. C.			Negl	Mod	Inh
Karaya Gum	R, S	I. C.			Negl	Mod	Inh
Lacquers	C	P	100%		Negl-Mod	Mod-Mkd	Cont
Lanolin	C	P	100%		Negl	Mod	Cont
Latex	C	P	100%		Negl	Mod	Cont
Leathers	C	P	as is		Negl	Slt	Cont
Lysol	C	P	1%	Aq	Negl	Mod	Cont
Mercury bichloride	C	P	0.1%	Aq	Negl	Mod	Cont
Metals	C	P	as is		Negl	Slt-Mod	Cont
Metal alloys	C	P	as is		Negl	Slt-Mod	Cont
Methyl salicylate	C	P	2%	Petr	Mkd	Mod	Cont
Mold spores	R, S	I. C			Negl	Mod-Mkd	Inh
Mucilage	C	P	100%		Negl	Mod	Cont
Mustard oil	C	P	1%	Alc	Negl	Mod	Cont
Nickel sulfate	C	P	5%	Aq	Negl	Mod	Cont

Table 3. Common Allergens, Their Effects and Methods of Testing (cont.)

Substance	Symptoms	Type of Test	Concentration or % for Testing	Vehicle	Danger of Sensitization by Testing	Allergenic Potential	Action: Contact, Inhalation
"Novocaine"	C	P	1%	Aq	Negl	Mod	Cont
Nylon	C R, S	P I. C.	as is		Negl Negl	Slt Slt	Cont Inh
Oats	C R, S	P I. C.	as is		Negl Negl	Slt Slt	Cont Inh
Orange oil	C	P	1%	Alc	Negl	Mod	Cont
Orris root	C R, S	P I. C.	as is		Negl Negl	Slt Mod	Cont Inh
Paraphenylenediamine	C	P	2%	Petr	Mod	Mkd	Cont
Peanut	R, S	I. C.			Negl	Mkd	Inh
Penicillin	C R, S	P I. C.	Var Var	Aq	Slt Slt	Mkd Mkd	Cont Inh
Perfume oils	C	P	1%	Petr	Negl	Mod	Cont
Phenol	C	P	2%	Aq	Negl	Slt	Cont
Photographic developers	C	P	5%	Aq	Negl	Mod	Cont
Picric acid	C	P	1-5%	Aq	Negl	Mod	Cont
Plants	C	P	as is		Slt-Mkd	Slt-Mkd	Cont
Poison Ivy	C	P	0.01%	Acet	Very Mkd	Very Mkd	Cont
Poison oak	C	P	0.01%	Acet	Very Mkd	Very Mkd	Cont
Poison sumac	C	P	0.01%	Acet	Very Mkd	Very Mkd	Cont
Powder, cleansing	C	P	as is		Negl	Slt	Cont
Potassium dichromate	C	P	0.5%	Aq	Negl	Mod	Cont
Primrose	C	P	25%	Aq	Very Mkd	Mkd	Cont
Pyrethrum	C R, S	P I. C.	20%	Alc	Negl Negl	Mkd Mkd	Cont Inh
Ragweed leaf	C	P	as is		Negl	Mod	Cont
Ragweed pollen	C R, S	P I. C.	1-5%	Petr	Negl Negl	Mod Mkd	Cont Inh
Resins	C	P	50-100%	Alc or Petr	Negl to Mkd	Mod to Mkd	Cont

Table 3. Common Allergens, Their Effects and Methods of Testing (cont.)

Substance	Symptoms	Type of Test	Concentration or % for Testing	Vehicle	Danger of Sensitization by Testing	Allergenic Potential	Action: Contact, Inhalation
Rubber, natural	C	P	as is		Negl	Mod	Cont
Rubber, synthetic	C	P	as is		Negl	Mod	Cont
Sawdust	C R, S	P I. C.	as is		Negl Negl	Low Low	Cont Inh
Shellacs	C	P	50-100%	Alc	Negl to Slt	Mod	Cont
Silk	R, S	I. C.	Test Dil		Negl	Mod	Inh
Silver nitrate	C	P	5%	Aq	Negl	Slt	Cont
Soaps	C	P	1-3%	Aq	Negl	Slt-Mkd	Cont
Sulfonamides	C	P	5-50%	Petr	Mod	Mkd	Cont
Sulfur, ppt.	C	P	5%	Petr	Negl	Mod	Cont
Tannic acid	C	P	1%	Aq	Negl	Mod	Cont
Tars	C	P	as is	Do not cover	Negl	Mod	Cont
Tobacco	C R, S	P I. C.	as is		Negl Negl	Mod Mod	Cont Inh
Tulip bulb	C	P	as is		Negl	Low	Cont
Turpentine	C	P	25-50%	Petr	Negl	Slt	Cont
Varnishes	C	P	25-100%	Alc or Petr	Negl to Slt	Slt to Mod	Cont
Vegetables	C	P	as is		Negl	Slt-Mod	Cont
Waxes	C	P	25-50%	Petr	Negl	Slt-Mod	Cont
Wheat	C R, S	P I. C.	as is		Negl Negl	Mod Mod	Cont Inh
Wintergreen oil	C	P	0.5%	Alc	Very Mkd	Mkd	Cont
Wood and pulp	C R, S	P I. C.	as is		Negl Negl	Low Low	Cont Inh
Wools	C R, S	P I. C.	as is		Negl Negl	Mod Mod	Cont Inh

Foods and inhalant allergens are generally used for intracutaneous testing. Chemicals such as aspirin, penicillin, and formaldehyde should not be used since severe reactions may result (see Table 3).

The Scratch Test. This is a relatively simple test consisting merely of the application of the test material in proper dilution to a tiny scratch made into the skin. The reactions are recorded in 5 to 15 minutes as 1+

to 4+. This test is much less sensitive and less reliable than the intracutaneous test (see Table 3).

The Ophthalmic Test. This test is performed by instilling a drop of the properly prepared extract into the conjunctival sac and noting the reactions. Watering and itching of the eyes result quite quickly if the test is positive. This test is sometimes used to detect sensitivity to inhaled allergens. It is, however, quite unpredictable and therefore not recommended unless the physician feels that there is no other way to determine sensitivity (see Table 3).

Both the scratch and ophthalmic tests are explained here in order to be complete. They are, however, not mentioned in Table 3 because they are not the usual or even preferred method of testing.

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SECTION 10

GENERAL CHEMICALS

ABBREVIATIONS USED IN SECTION 10

ACGIH	American Council of Governmental and Industrial Hygienists
anh.	anhydrous
atm.	atmospheres
Autoign. Temp.	autoignition temperature
B. P.	boiling point
C. C.	closed cup
C. O. C.	Cleveland open cup
decomp.	decomposition
°C	degrees centigrade
°F	degrees Fahrenheit
Flash P.	flash point
I. C. C.	Interstate Commerce Commission
L. E. L.	lower explosive limit
MAC	maximum allowable concentration
MCA	Manufacturing Chemists' Association
M. P.	melting point
mm	millimeters
Mol. Wt.	molecular weight
O. C.	open cup
T. O. C.	Tag open cup
U. E. L.	upper explosive limit
Vap. D.	vapor density
Vap. Press.	vapor pressure

A

ABIETIC ACID

Synonyms: Abietinic acid, sylvic acid.
Description: Yellow powder.
Formula: $C_{20}H_{30}O_2$
Constants:
  Mol. Wt. 302.4
  M. P. 172 - 175°C
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2
  Acute Systemic: Ingestion 1
  Chronic Local: Irritant 2
  Chronic Systemic: U
Fire Hazard: Slight; emits acrid fumes when exposed to flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Slight, if dust is exposed to flame or sparks.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ABRIN

Synonym: Toxalbumin
Description: Yellowish-white powder.
Toxic Hazard Rating:
  Acute Local: 0
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 1
  Chronic Local: U
  Chronic Systemic: U
Caution: Exceedingly toxic in eye and nose. Smallest particle in a wound may be fatal.
Fire Hazard: Slight.
Disaster Control: Dangerous, when heated to decomposition, emits highly toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

ABSINTHIUM

Synonym: Wormwood
Description: Dried leaves and flowering tops of Artemisia absinthium L.
Toxic Hazard Rating:
  Acute Local: Allergen 2
  Acute Systemic: Ingestion 3
  Chronic Local: Allergen 2
  Chronic Systemic: Ingestion 2
Caution: Habitual users develop "absinthism," with tremors, vertigo, vomiting and hallucinations. Local contact may cause contact dermatitis (Section 9).
Fire Hazard: Slight.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

ACACIA GUM

Synonym: Gum arabic.
Description: Spheres or "tears"
Constants:
  Mol. Wt. 240,000
  Density 1.35-1.49
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: 0
  Chronic Local: Allergen 1
  Chronic Systemic: 0
Caution: Local contact may cause contact dermatitis. Inhalation as dust may cause respiratory symptoms such as asthma, watery nose and eyes, cough and wheezing. Hives, eczema and angioedema may also result from inhalation or ingestion (Section 9).
Fire Hazard: Slight (Section 6).
Personal Hygiene: Section 3

ACACIA WOOD

Toxic Hazard Rating:
  Acute Local: Allergen 1; Inhalation 1
  Acute Systemic: 0
  Chronic Local: Allergen 1; Inhalation 1
  Chronic Systemic: 0
Toxicology: Toxicity by inhalation is that of any wood dust. Local contact may cause contact dermatitis (Section 9).

Toxic Rating Code: 0 = None 1 = Slight 2 = Moderate 3 = High U = Unknown

Fire Hazard: Slight, can react with oxidizing materials.
Storage and Handling: Section 7

ACENAPHTHENE

Synonym: Naphthalene ethylene.
Description: White, elongated crystals.
Formula: $C_{10}H_6(CH_2)_2$
Constants:
Mol. Wt. 154.2
M. P. 95°C
B. P. 277.5°C
Density 1.024 @99°/4°C
Vap. Press. 10 mm @131.2°C
Vap. D. 5.32
Toxicity: Unknown
Caution: May cause vomiting if swallowed in large quantities.
Fire Hazard: Slight; it emits acrid fumes when heated; reacts with oxidizing materials (Section 6).
Storage and Handling: Section 7

ACETAL

Synonyms: 1, 1-Diethoxyethane; diethylacetal.
Description: Colorless, volatile liquid; agreeable odor; nutty aftertaste.
Formula: $CH_3CH(OC_2H_5)_2$
Constants:
Mol. Wt. 118.17
B. P. 102.0°C
Flash P. -5°F (C.C.)
Density 0.831
Autoign. Temp. 446°F
Vap. Press. 10 mm @8.0°C
Vap. D. 4.08
Toxic Hazard Rating:
Acute Local: Inhalation 1
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: Ingestion 1; Inhalation 1
Toxicology: No cases of industrial intoxication are known. It is narcotic and more toxic than paraldehyde. Conclusions are based upon animal experiments. High concentrations in air cause narcosis.
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame. Old samples have been known to explode upon heating.
Explosive Range: 1.65% (lower limit)
Disaster Control: Dangerous, due to fire and explosion hazards.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

ACETALDEHYDE

Synonyms: Acetic aldehyde; ethyl aldehyde.
Description: Colorless, fuming liquid; pungent, fruity odor.
Formula: CH_3CHO
Constants:
Mol. Wt. 44.05
M. P. -123.5°C
B. P. 20.8°C
Flash P. -36°F (C.C.)
Density 0.7827 @20°/20°C
Autoign. Temp. 365°F
Vap. D. 1.52
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: Irritant 1
Chronic Systemic: Ingestion 2; Inhalation 2
MAC: ACGIH (accepted); 200 parts per million in air; 360 milligrams per cubic meter of air.
Toxicology: It has a general narcotic action on the central nervous system. In chronic intoxication the symptoms resemble those of chronic alcoholism. It is irritating to the eyes. High concentrations cause headache and stupefaction.
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Severe when exposed to flame.
Explosive Range: 4.0 - 57.0%

Disaster Control: Highly dangerous due to fire and explosion hazard.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.
MCA warning label.

ACETALDEHYDE AMMONIA. See Aldehyde Ammonia.

ACETALDOL. See Aldol.

ACETAMIDE

Synonym: Acetic acid amine.
Description: Colorless, mobile liquid; mousy odor.
Formula: CH_3CONH_2
Constants:
Mol. Wt. 59.07
M. P. 81°C; B. P. 222°C
Density 1.159 @20°/4°C
Vap. Press. 1 mm @65.0°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 1
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of cyanides.
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-ACETAMIDOFLUORENE

Description: Powder.
Formula: $C_6H_4CH_2C_6H_3NHCOCH_3$
Constant: Mol. Wt. 223.3
Toxicity: Details unknown; an insecticide.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of cyanide.
Storage and Handling: Section 7

ACETANILIDE

Synonyms: N-Phenylacetamide antifebrin.
Description: White, shining crystalline scales.
Formula: $CH_3CONHC_6H_5$
Constants: Mol. Wt. 135.16
M. P. 113.5°C
B. P. 303.8°C
Flash P. 345°F (O. C.)
Density 1.2105 @4°/4°C
Autoign. Temp. 1015°F
Vap. Press. 1 mm @114.0°C
Vap. D. 4.65
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: Ingestion 2; Inhalation 1
Chronic Local: Allergen 1
Chronic Systemic: Ingestion 2; Inhalation 2
Toxicology: In experimental poisoning a variety of effects have been reported, depending on the animal or tissue used for testing. Acute poisoning in humans may occur if several grams are taken by mouth. Cyanosis is a prominent finding in both acute and chronic poisoning. Habitual use of acetanilide for relief of headache has resulted in damage to the blood forming organs, with anemia and cyanosis. The latter is due to the presence of methemoglobin. Sulfhemoglobin has also been demonstrated in such cases. Habitual use may cause serious injury to the blood. It may also cause contact dermatitis and inhalation or ingestion may cause an exematous eruption of the skin (Section 9).
Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of aniline.
Ventilation Control (normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ACETATE RAYON

Caution: Skin rashes from rayon garments are usually due to dyes, conditioners or other chemicals added to the rayon (Section 9).
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).

Storage and Handling: Section 7

ACETIC ACID

Synonyms: Methane carboxylic acid; vinegar acid; ethanoic acid.
Description: Clear, colorless liquid; pungent odor.
Formula: CH_3COOH
Constants:
  Mol. Wt. 60.05
  M. P. 16.7°C
  B. P. 118.1°C
  Flash P. 104°F (C. C.)
  Density 1.049 @20°/4°C
  Autoign. Temp. 1050°F
  Vap. Press. 10 mm @17.5°C; 11.4 mm @20°C
  Vap. D 2.07
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 2
  Acute Systemic: U
  Chronic Local: Irritant 2
  Chronic Systemic: U
MAC: ACGIH (accepted); 10 parts per million in air; 26 milligrams per cubic meter of air.
Toxicology: Caustic, irritating, can cause burns, lachrymation and conjunctivitis. It penetrates the skin easily and can cause dermatitis and ulcers. Inhalation causes irritation of mucous membranes. In case of contact with skin, eyes or clothing, immediately flush skin or eyes with plenty of water and remove all contaminated clothing. If swallowed give magnesia, chalk or whiting in water.
Fire Hazard: Moderate, when exposed to heat or flame; can react vigorously with oxidizing materials (Section 6).
Spontaneous Heating: No
Caution: Particularly dangerous in contact with chromic acid, sodium peroxide, nitric acid.
To Fight Fire: Carbon dioxide, dry chemical, or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 4.0% (lower limit)
Disaster Control: Dangerous; when heated to decomposition, emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  Coast Guard Classification: Combustible liquid.
  MCA warning label.

ACETIC ACID 80%; 56-70%; 28%.

See Acetic Acid.

ACETIC ACID, GLACIAL.

See Acetic Acid.

ACETIC ANHYDRIDE

Synonyms: Acetyl oxide; acetic oxide; ethanoic anhydride.
Description: Colorless, very mobile, strongly refractive liquid; very strong acidic odor.
Formula: $(CH_3CO)_2O$
Constants:
  Mol. Wt. 102.09
  M. P. -73.1°C
  B. P. 140°C
  Flash P. 121°F (C.C.)
  Density 1.082 @20°/4°C
  Autoign. Temp. 752°F
  Vap. Press. 10 mm @36.0°C
  Vap. D. 3.52
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 2
  Acute Systemic: U
  Chronic Local: Irritant 2
  Chronic Systemic: U
MAC: ACGIH (accepted); 5 parts per million in air; 21 milligrams per cubic meter of air.
Toxicology: An irritant, corrosive on contact with tissue, particularly the eyes and upper respiratory tract. Systemic effects can be avoided by heeding the warning of its presence—coughing and a burning sensation in nose and throat. Ingestion causes a burning pain in the stomach followed by nausea and vomiting. If not removed from skin at once it will cause a reddening which may be followed by wrinkling, whitening and peeling. Continued contact with skin can cause dermatitis (Section 9). It is especially hazardous to the eyes, with delayed action causing eye burns.
Fire Hazard: Moderate, when exposed to heat or flame.

Spontaneous Heating: No

To Fight Fire: Carbon dioxide, dry chemical, or carbon tetrachloride (Section 6).

Explosion Hazard: Moderate, when exposed to flame.

Explosive Range: 2.67 - 10.13%

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; can react vigorously with oxidizing materials; will react violently on contact with water or steam.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations: Section 11.
  Coast Guard Classification: Combustible liquid.
  MCA warning label.

ACETOACETANILIDE

Synonyms: beta-Ketobutyranilide; alpha-acetyl acetanilide.

Description: White crystalline solid.

Formula: $CH_3COCH_2CONHC_6H_5$

Constants:
  Mol. Wt. 177.2
  M. P. 85°C
  B. P. Decomposes
  Flash P. 325°F (C.O.C.)
  Density 1.260 @20°C
  Vap. Press. 0.01 mm @20°C

Toxicity: Details unknown; a weak allergen (Section 9). See also Acetanilide.

Fire Hazard: Slight, when exposed to heat or flame.

To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of aniline and cyanides.

Storage and Handling: Section 7

ACETOACET-o-ANISIDIDE

Description: Crystals.

Formula: $CH_3COCH_2CONHC_6H_4OCH_3$

Constants:
  Mol. Wt. 207.22
  M. P. 86.6°C
  Flash P. 365°F (O.C.)
  Density 1.132 @86.6°/20°C

Toxicity: Unknown

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

ACETOACET-o-CHLORANILIDE

Description: Crystals.

Formula: $CH_3COCH_2CONHC_6H_4Cl$

Constants:
  Mol. Wt. 211.65
  M. P. 107°C; B. P. Decomposes
  Flash P. 350°F (C.O.C.)
  Density 1.438 @20°C
  Vap. Press. 0.01 mm @20°C
  Vap. D. 7.31

Toxicity: See Acetanilide.

Fire Hazard: Slight, when exposed to heat or flame.

To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes of aniline, phosgene and cyanides; can react vigorously with oxidizing materials.

Ventilation Control (use normal rate): Section 2

Personal Hygiene: Section 3

Storage and Handling: Section 7

ACETOACET-p-CHLORANILIDE

Description: Crystals.

Formula: $CH_3COCH_2CONHC_6H_4Cl$

Constants:
  Mol. Wt. 211.65
  M. P. 133°C
  B. P. Decomposes
  Flash P. 320°F (O.C.)
  Density 1.348 @20°C
  Vap. Press. < 0.01 mm @20°C
  Vap. D. 7.31

Toxicity: See Acetanilide.

Fire Hazard: Slight, when exposed to heat or flame.

To Fight Fire: Water, foam, carbon dioxide, dry chemical, or carbon tetrachloride (Section 6).

Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes of aniline, phosgene and cyanides; can react vigorously with oxidizing materials.

Ventilation Control (use normal rate): Section 2

Personal Hygiene: Section 3
Storage and Handling: Section 7

ACETOACETIC ACID

Synonym: Acetyl acetic acid.
Description: Colorless syrup.
Formula: CH_3COCH_2COOH
Constants:
- Mol. Wt. 102.1
- B. P. < 100 °C (decomp.)

Toxicity: Unknown
Fire Hazard: Slight; when heated, emits acrid fumes; reacts with oxidizing materials.
Storage and Handling: Section 7

ACETOACET-p-PHENETIDIDE

Description: Crystals.
Formula: $CH_3COCH_2CONHC_6H_4OC_2H_5$
Constants:
- Mol. Wt. 221.25
- M. P. 108.5 °C
- B. P. Decomposes
- Flash P. 325 °F (O. C.)
- Density 1.220 @ 20 °C
- Vap. Press. 0.02 mm @ 20 °C
- Vap. D. 7.63

Toxicity: See Acetanilide.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

ACETOACET-o-TOLUIDIDE

Description: Crystals.
Formula: $CH_3COCH_2CONHC_6H_4CH_3$
Constants:
- Mol. Wt. 191.22
- M. P. 106 °C
- B. P. Decomposes
- Density 1.300 @ 20 °C
- Vap. Press. 0.01 mm @ 20 °C
- Flash P. 320 °F (C. O. C.)

For details see Aceto-p-phenetidide.

ACETOGUANAMINE

Description: Crystals.
Formula: $CH_3(C_3N_3)(NH_2)_2$
Constants:
- Mol. Wt. 125.15
- M. P. 270 °C (decomp.)
- Density 1.44

Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

ACETOL

Synonyms: Acetylsalicylic acid; aspirin.
Description: White crystals.
Formula: $CH_3COOC_6H_4COOH$
Constants:
- Mol. Wt. 180.2
- M. P. 135 °C
- Density 1.35

Toxic Hazard Rating:
- Acute Local: Allergen 1; Ingestion 2
- Acute Systemic: Ingestion 1; Inhalation 1
- Chronic Local: Allergen 1
- Chronic Systemic: U

Caution: Ten grams may be fatal. Contact, inhalation or ingestion can cause asthma, sneezing, irritations and watering of eyes and nose as well as hives and eczema (Section 9).
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

ACETONE

Synonyms: Dimethyl ketone; ketone propane; propanone.
Description: Colorless liquid; fragrant mint-like odor.
Formula: CH_3COCH_3
Constants:
- Mol. Wt. 58.08
- M. P. −94.6 °C
- B. P. 56.48 °C
- Flash P. 0 °F (C. C.)
- Density 0.7972 @ 15 °C
- Autoign. Temp. 1000 °F
- Vap. Press. 400 mm @ 39.5 °C
- Vap. D. 2.00

Toxic Hazard Rating:
- Acute Local: Irritant 1; Ingestion 2; Inhalation 2
- Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
- Chronic Local: Irritant 1
- Chronic Systemic: Ingestion 1; Inhalation 1; Skin Absorption 1

MAC: ACGIH (accepted); 1000 parts per million in air; 2400 milligrams per cubic meter of air.

Toxicology: Acetone is narcotic to animals in very high concentrations. Cats are anesthetized by concentrations of 8,000 to 17,000 ppm and above, but repeated exposures to concentrations of 2,000 ppm cause no ill effects other than slight irritation of the eyes and nose. In industry, no injurious effects from its use have been reported, other than the occurrence of skin irritations resulting from its de-fatting action. It can give rise to bronchial catarrh and headache.

Fire Hazard: Dangerous, when exposed to heat or flame.

Underwriters Laboratory Classification: 90

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Moderate, when vapor is exposed to flame.

Explosive Range: 2.55 - 12.8%

Disaster Control: Dangerous, due to fire and explosion hazard; can react vigorously with oxidizing materials.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations: Section 11.
- I. C. C. Classification: Flammable liquid; red label.
- Coast Guard Classification: Inflammable liquid; red label.
- MCA warning label.

ACETONE CYANHYDRIN

Synonym: Oxyisobutyric nitrile.

Description: Liquid.

Formula: CH_3COCH_3HCN

Constants: Mol. Wt. 85.10
- M. P. −20°C
- B. P. 82°C @23 mm
- Density 0.932 @19°C
- Autoign. Temp. 1270°F
- Vap. D. 2.93

Toxic Hazard Rating:
- Acute Local: Irritant 1
- Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 2
- Chronic Local: 0
- Chronic Systemic: U

Caution: This material readily decomposes to hydrogen cyanide and acetone. It must be kept slightly acidfied. It should not be stored for long periods and it should be kept cool. See also Hydrocyanic Acid and Acetone.

Fire Hazard: Slight, when exposed to heat or flame.

To Fight Fire: Carbon dioxide, dry chemical, or carbon tetrachloride (Section 6).

Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes of cyanide.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations: Section 11.
- I. C. C. Classification: Poison B; poison label.
- Coast Guard Classification: Poison B; poison label.

ACETONEDICARBOXYLIC ACID

Synonym: beta-Ketoglutaric acid.

Description: White crystals.

Formula: $C_5H_6O_5$

Constants:
- Mol. Wt. 146.10
- M. P. 135°C (decomp.)

Toxicity: Unknown

Fire Hazard: Slight; when heated, it emits acrid fumes.

Storage and Handling: Section 7

ACETONE OIL

Description: (a) Standard: light, lemon-yellow. (b) Refined: almost water white. (c) Heavy: dark, orange-yellow.

Constants:
- B. P. (a) 75-160°C; (b) 75-105°C; (c) 80-225°C
- Density (a) 0.826-0.830 (b) 0.812; (c) 0.885-0.865

Toxicity: Unknown

Fire Hazard: Dangerous; when exposed to heat or flame.

To Fight Fire: Carbon dioxide, dry chemical, or carbon tetrachloride (Section 6).

Explosion Hazard: Moderate, when exposed to flame.

Disaster Control: Dangerous; can react vigorously with oxidizing materials.

Storage and Handling: Section 7

Shipping Regulations: Section 11.
I.C.C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.
MCA warning label.

ACETONE PEROXIDE

Description: Liquid.
Toxicity: Details unknown. See also Peroxides, Organic.
Fire Hazard: Moderate, by spontaneous chemical reaction; when heated, it emits acrid fumes; can react vigorously with reducing materials (Section 6).
Explosion Hazard: Moderate, when shocked.
Storage and Handling: Section 7

ACETONE SEMICARBAZONE

Formula: $(CH_3)_2CNNHCONH_2$
Constant:
Mol. Wt. 115.1
Toxicity: Details unknown; an insecticide.
Disaster Control: Moderately dangerous; when heated to decomposition, emits toxic fumes.
Storage and Handling: Section 7

ACETONITRILE. See Methylcyanide

ACETONYL ACETONE

Synonyms: Hexanedione-2,5; 1,2-diacetylethane.
Description: Colorless liquid.
Formula: $CH_3COCH_2CH_2COCH_3$
Constants:
Mol. Wt. 114.14
M. P. -9°C
B. P. 192.4°C
Flash P. 174°F (C.C.)
Density 0.970 @ 20°/4°C
Autoign. Temp. 920°F
Vap. D. 3.94
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Caution: Can irritate the eyes.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use optional): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

3-(alpha-ACETONYLBENZYL)-4-HYDROXYCOUMARIN

Synonym: Warfarin.
Description: Colorless, crystalline solid.
Formula: $C_{19}H_{16}O_4$
Constants:
Mol. Wt. 308.2
M. P. 159-161°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 1; Inhalation 1
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
MAC: ACGIH (tentative); 0.5 mg per cubic meter of air.
Storage and Handling: Section 7

3-(alpha-ACETONYLFURFURYL)-4-HYDROXYCOUMARIN

Description: White powder.
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3
Caution: This rodenticide is almost always used mixed with bait preparations unpalatable to humans. However, in case of accidental ingestion, induce vomiting until fluid is clear. Administer vitamin K (oral or intravenous) in large doses. Call a physician immediately.
Fire Hazard: Slight; when heated it evolves acrid fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ACETOPHENETIDINE

Synonyms: p-Acetophenetide; phenacetin.
Description: Glistening, crystalline

powder.
Formula: $CH_3CONHC_6H_4OC_2H_5$
Constants:
Mol. Wt. 179.21
M. P. 138°C
Toxic Hazard Rating:
Acute Local: Ingestion 2; Inhalation 1
Acute Systemic: Ingestion 2; Inhalation 1
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 1
Toxicology: A dose of 0.5 gram of this material has caused death. Although it is considered less toxic than acetanilide, the symptoms of poisoning from it are nearly identical: weakness, dizziness, depression, collapse and very evident cyanosis. Chronic effects consist of loss of weight, insomnia, shortness of breath, weakness and often anemia.
Disaster Control: Moderately dangerous; when heated to decomposition it emits highly toxic fumes.
Ventilation Control (normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

ACETOPHENONE
Synonyms: Phenyl methyl ketone.
Description: Colorless liquid.
Formula: $C_6H_5COCH_3$
Constants:
Mol. Wt. 120.14
M. P. 20.5°C
B. P. 202°C
Flash P. 221°F (C.C.)
Density 1.033 @15°/15°C
Vap. Press. 1 mm @37.1°C
Vap. D. 4.14
Toxicity: Details unknown.
Caution: A hypnotic. See also Ketones.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ACETOPHENONE OXIME
Formula: $C_6H_3O(NOH)CH_3$
Constant: Mol. Wt. 139.2
Toxicity: Details unknown; an insecticide.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of cyanides.
Storage and Handling: Section 7

p-ACETOTOLUIDIDE
Synonym: p-Tolylacetamide.
Description: Crystals.
Formula: $CH_3C_6H_4NHCOCH_3$
Constants:
Mol. Wt. 149.1
B. P. 307°C
Flash P. 335°F (C.C.)
Density 1.212
Vap. D. 5.14
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical, or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ACETOXY MERCURI BENZO THIOPHENE
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury and oxides of sulfur.
Storage and Handling: Section 7

ACETYLACETONE. See Pentanedione-2,4.

ACETYL BENZOYL PEROXIDE
Synonym: Acetozone.
Description: White crystals.
Formula: $C_6H_5COOOCOCH_3$
Constants:
Mol. Wt. 180.2
M. P. 36 - 37°C
B. P. 130°C @19 mm
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 2
Acute Systemic: U
Chronic Local: Irritant 2; Ingestion 1; Inhalation 2
Chronic Systemic: U
Caution: This material is a powerful oxidizing agent which is corrosive to skin and mucous membranes.

Fire Hazard: Moderate, by spontaneous chemical reaction.
To Fight Fire: Carbon dioxide or dry chemical (Section 6).
Explosion Hazard: Moderate, when shocked or exposed to heat.
Disaster Control: Dangerous; shock or heat will cause detonation with evolution of toxic fumes; will react with water or steam to produce heat; can react vigorously with reducing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Not accepted.
  Coast Guard: Not permitted.

ACETYL BENZOYL PEROXIDE, SOLUTION. See also Acetyl Benzoyl Peroxide.

Shipping Regulations: Section 11.
  I. C. C. Classification: Oxidizing material; yellow label.
  Coast Guard: Oxidizing material; yellow label.

ACETYL BENZYL PEROXIDE, DRY

Description: Powder.
Toxicity: Details unknown.
Fire Hazard: Moderate, by spontaneous chemical reaction (Section 6).
Caution: A powerful oxidizing agent.
Explosion Hazard: Moderate, when shocked or exposed to heat.
Disaster Control: Dangerous; shock will cause detonation with evolution of toxic fumes; will react with water and steam to produce heat; can react vigorously with reducing materials.
Storage and Handling: Section 7

ACETYL BENZYL PEROXIDE, WET

Toxicity: Details unknown. See also Peroxides, Organic.
Fire Hazard: Moderate, by spontaneous chemical reaction (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; can react vigorously with reducing materials.
Storage and Handling: Section 7

ACETYL BROMIDE

Synonym: Ethanoyl bromide.
Description: Colorless fuming liquid; turns yellow in air.
Formula: CH_3COBr
Constants:
  Mol. Wt. 122.96
  M. P. −96.5°C
  B. P. 76.7°C
  Density 1.52 @ 9.5°/4°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Caution: This material readily hydrolyzes. See also Hydrobromic Acid, Acetic Acid.
To Fight Fire: Dry chemical, carbon dioxide, or carbon tetrachloride (Section 6).
Explosion Hazard: Slight, by spontaneous chemical reaction; decomposes violently upon contact with moisture.
Disaster Control: Dangerous; when heated to decomposition, it emits highly corrosive and toxic fumes of carbonyl bromide and bromine; will react with water or steam to produce heat.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ACETYL CHLORIDE

Synonym: Ethanoyl chloride.
Description: Colorless, fuming liquid.
Formula: CH_3COCl
Constants:
  Mol. Wt. 78.50
  M. P. −112°C
  B. P. 51 - 52°C
  Flash P. 40°F (C. C.)
  Density 1.1051 @20°/4°C
  Vap. D. 2.70
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Caution: It readily hydrolyzes to

form hydrogen chloride and acetic acid. See also Hydrochloric Acid, Acetic Acid.
Fire Hazard: Dangerous, when exposed to heat or flame; reacts violently with water.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, or dry chemical (Section 6).
Explosion Hazard: Slight, by spontaneous chemical reaction.
Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes of phosgene; will react with water or steam to produce heat and toxic or corrosive fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Corrosive liquid; white label.
  Coast Guard Classification: Corrosive liquid; white label.
  MCA warning label.

ACETYLENE

Synonyms: Ethyne; ethine.
Description: Colorless gas; garlic-like odor.
Formula: HC≡CH
Constants:
  Mol. Wt. 26.04
  B. P. −84.0°C (sublimes)
  M. P. −81.8°C
  Flash P. 0°F (C. C.)
  Density 1.173 grams per liter @0°C
  Autoign. Temp 635°F
  Vap. Press. 40 atm @16.8°C
  Vap. D. 0.91
Toxic Hazard Rating:
  Acute Local: 0
  Acute Systemic: Inhalation 2
  Chronic Local: 0
  Chronic Systemic: Inhalation 1
Caution: When mixed with oxygen, in proportions of 40 per cent or more acetylene also acts as a narcotic and has been used in anesthesia. Acetylene also acts as a simple asphyxiant, by diluting the oxygen in the air to a level which will not support life. However, the presence of impurities in commercial acetylene may result in the production of symptoms before an asphyxiant concentration is reached. Dizziness, headache, mild gastric symptoms, and in high concentrations, semi-asphyxia and brief loss of consciousness have all been reported. In general industrial practice, however, acetylene does not constitute a serious hazard. See Argon for discussion of simple asphyxiants.
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, water spray, or dry chemical.
Explosion Hazard: Moderate, when exposed to heat or flame or by spontaneous chemical reaction. At high pressures and even moderate temperatures, acetylene has been known to decompose explosively. Forms explosive compounds with copper and silver (See Acetylides).
Explosive Range: 2.5 - 80%
Disaster Control: Dangerous, shock can shatter the compressed gas container with explosive force; when heated, it burns with an intensely hot flame; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable gas; red gas label.
  Coast Guard Classification: Inflammable gas; red gas label.

ACETYLENE CHLORIDE

Synonym: Chloroethyne
Description: Gas
Formula: CHCCl
Constants:
  Mol. Wt. 60.5
  B. P. −32 to −30°C
  Density 2.0
Toxicity: Unknown
Fire Hazard: Dangerous, by spontaneous chemical reaction (Section 6).
Spontaneous Heating: Spontaneously flammable in air.
Explosion Hazard: Severe, when shocked or exposed to heat.
Disaster Control: Dangerous; shock will explode it; when heated to

decomposition, emits highly toxic fumes of phosgene; can react vigorously with oxidizing materials.

Storage and Handling: Section 7

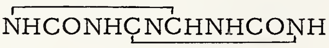
ACETYLENE DICHLORIDE. See Dichloroethylene

ACETYLENE DIUREINE

Synonym: Glycol uril.

Description: White, needle-like crystals.

Formula:



$NHCONHCNCHNHCONH$

Constants: Mol. Wt. 142.12

Density 1.599

Toxicity: Unknown

Fire Hazard: Slight; when heated to decomposition it emits toxic fumes (Section 6).

Storage and Handling: Section 7

ACETYLENE TETRABROMIDE

Synonym: Tetrabromoethane.

Description: Colorless to yellow liquid.

Formula: $CHBr_2CHBr_2$

Constants:

Mol. Wt. 345.70

B. P. 151°C @ 54 mm

Freezing P. −1°C

Density 2.9638 @ 20°/4°C

Toxic Hazard Rating:

Acute Local: Irritant 2; Ingestion 2; Inhalation 2

Acute Systemic: U

Chronic Local: U

Chronic Systemic: U

Disaster Control: Dangerous; when heated, it emits highly toxic fumes of carbonyl bromide.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

ACETYLENE TETRACHLORIDE

Synonyms: Tetrachloroethane-1,1,2,2

Description: Heavy, colorless, mobile liquid; chloroform-like odor.

Formula: $CHCl_2CHCl_2$

Constants:

Mol. Wt. 167.86

M. P. −43.8°C

B. P. 146.3°C

Density 1.600 @ 20°/4°C

Toxic Hazard Rating:

Acute Local: Irritant 2; Ingestion 3; Inhalation 3

Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3

Chronic Local: U

Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3

MAC: (ACGIH accepted); 5 parts per million in air; 34 milligrams per cubic meter of air.

Toxicology: This is generally considered the most toxic of the common chlorinated hydrocarbons. It has a fairly strong irritant action on the mucous membranes of the eyes and upper respiratory tract; a concentration of 3 ppm produces a detectable odor. There is thus an initial warning effect. Its narcotic action is stronger than that of chloroform, but because of its low volatility, narcosis is less severe and much less common in industrial poisoning than in the case of other chlorinated hydrocarbons. The toxic action of this material is chiefly on the liver, where it produces acute yellow atrophy and cirrhosis. Fatty degeneration of the kidneys and heart, hemorrhage into the lungs and serous membranes, and edema of the brain have also been found in fatal cases. Some reports indicate a toxic action on the central nervous system, with changes in the brain and in the peripheral nerves. The effect on the blood is one of hemolysis, with appearance of young cells in the circulation and a monocytosis. Due to its solvent action on the natural skin oils, dermatitis is not uncommon (Section 9).

The initial symptoms resulting from exposure to the vapor are lacrimation, salivation and irritation of the nose and throat. Continued exposure to high concentrations results in restlessness, dizziness, nausea and vomiting and narcosis. The latter, however, is rare in industry. More commonly, the exposure is less severe, and the complaints are vague and referable to the digestive and nervous systems. The patient's complaints gradually progress to serious illness, with development of a toxic jaundice, liver tenderness, etc., and possibly albuminuria and edema. With serious liver damage the jaundice increases and toxic symptoms appear, with somnolence, delirium, convulsions and coma usually preceding death.

This material is considered to be a very severe industrial hazard and its use has been restricted or even forbidden in certain countries.

Explosion Hazard: Moderate, in contact with sodium or potassium; when heated in contact with solid potassium hydroxide a spontaneously flammable gas is evolved. It may be used in the absence of air and dissolved water up to 120 °C. Any undissolved water causes appreciable hydrolysis even at room temperature and both hydrolysis and oxidation become comparatively rapid above 110 °C.

Disaster Control: Dangerous; when heated, it emits highly toxic decomposition products.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

N-ACETYL ETHANOLAMINE

Formula: $CH_3CONHCH_2CH_2OH$

Constants:
Mol. Wt. 103.1
Flash P. 350 °F
Density 1.12

Toxicity: Unknown

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

ACETYL GLYCOLIC ACID ETHYL ESTER

Description: Liquid.

Formula: $CH_3COOCH_2COOC_2H_5$

Constants: Mol. Wt. 146
B. P. 184 - 189 °C
Flash P. 349 °F
Density 1.094

Toxic Hazard Rating:
Acute Local: Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U

Fire Hazard: Slight, when exposed to heat or flame; can react vigorously with oxidizing materials (Section 6).

Ventilation Control (use normal rate): Section 2

Personal Hygiene: Section 3

Storage and Handling: Section 7

ACETYLIDES

Synonym: Carbides.

Toxicity: Unknown

Fire Hazard: Unknown

Explosion Hazard: Severe, when shocked or exposed to heat. Acetylides are very sensitive to shock, friction and heat. They explode readily and are one of the few commercial explosives which contain no oxygen or nitrogen. Their explosion produces no gas but simply is an effect of the large amount of heat, instantaneously produced. Acetylides are used for detonating compositions, or in combination with lead azide in detonating rivets where the acetylides reduce the flash point of the more insensitive azides. They are in a class with the fulminates and the azides as primary detonants.

Because these materials are so sensitive to shock and temperature, they must be handled with extreme care. They must be kept cool, and if they are to be stored, should be kept wet. (See Fulminates for suggested precautions in storage and handling of acetylides.) Metal powders, such as finely divided copper or silver should not be stored or kept with acetylene or acetylides, because it is possible for them to react with these metal powders to form very sensitive acetylides which, while they are not dangerous in themselves, can cause

enough of a flash to ignite a possibly explosive mixture of gases and thus cause an explosion in a warehouse or storage area (For destruction of acetylides, see Section 7). Examples of commercially used acetylides are silver acetylide and copper acetylide.
Storage and Handling: Section 7

ACETYL IODIDE

Synonym: Ethanoyl iodide.
Description: Brown, transparent, fuming liquid.
Formula: CH_3COI
Constants:
  Mol. Wt. 169.96
  B. P. 104 - 106 °C
  Density 2.067
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous, when heated to decomposition, it emits highly toxic fumes of iodine and iodides; will react with water or steam to produce toxic or corrosive fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

N-ACETYL MORPHOLINE

Description: Liquid.
Formula: $CH_3CO\underline{NCH_2CH_2OCH_2CH_2}$
Constants:
  Mol. Wt. 129.16
  M. P. 14 °C
  B. P. Decomposes
  Flash P. 235 °F (O.C.)
  Density 1.1164
  Vap. Press. 0.02 mm @ 20 °C
  Vap. D. 4.46
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ACETYL PEROXIDE

Synonym: Ethanoyl peroxide.
Description: Solid or colorless crystals.
Formula: $(CH_3CO)_2O_2$
Constants:
  Mol. Wt. 118.1
  M. P. 30 °C
  B. P. 63 °C @ 21 mm
  Density 1.18
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Dangerous, by spontaneous chemical reaction. A powerful oxidizing agent; can cause ignition of organic materials on contact.
To Fight Fire: Carbon dioxide, dry chemical, or carbon tetrachloride (Section 6).
Explosion Hazard: Severe, when shocked or exposed to heat. It may explode spontaneously possibly when more than 24 hours old; it should be used up as soon as prepared.
Disaster Control: Highly dangerous; shock will explode it; it will react with water or steam to produce heat; can react vigorously with reducing materials; can emit toxic fumes on contact with acid or acid fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Not accepted.
  Coast Guard Classification: Not permitted.

ACETYL PEROXIDE 25% SOLUTION (IN DIMETHYL PHTHALATE)

Synonym: Diacetyl peroxide solution.
Description: Crystal clear liquid.
Constants:
  M. P. -7 °C (approx.)
  Flash P. 113 °F (O.C.)
  Density 1.18 @ 20 °C
Toxic Hazard Rating:
  Acute Local: Irritant 2;

Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
See also Peroxides, Organic.
Fire Hazard: Moderate when exposed to heat or flame, or by spontaneous chemical reaction. An oxidizing agent.
To Fight Fire: Foam, carbon dioxide, or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, emits toxic fumes; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

1-ACETYL-2-PHENYLHYDRAZINE
Formula: $CH_3CONHNHC_6H_5$
Constant:
Mol. Wt. 150.2
Toxicity: Details unknown; an insecticide.
Disaster Control: Moderately dangerous; when heated to decomposition, it may emit toxic fumes.
Storage and Handling: Section 7

ACETYL SALICYLATE
Toxicity: Probably quite low. A weak sensitizer. Inhalation or ingestion may cause asthma, sneezing, etc.; contact may cause hives or eczema (Section 9).
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Slight
Storage and Handling: Section 7

ACETYL TRIBUTYL CITRATE
Description: Odorless powder.
Formula: $C_5H_7O_2(COOC_4H_9)_3$
Constants:
Mol. Wt. 402.5
B. P. 172 - 174°C @1 mm
Flash P. 204°C (C.O.C.)
Density 1.048 @25°/25°C
Toxicity Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ACETYL TRIETHYL CITRATE
Constant:
Flash P. 370°F (C.O.C.)
For further details see Acetyl Tributyl Citrate.

ACETYL TRI-2-ETHYL HEXYLCITRATE
Description: Liquid.
Formula: $CH_3CO_2C(CO_2C_8H_{17})$-$CH_2(CO_2C_8H_{17})CH_2(CO_2C_8H_{17})$
Constants:
Mol. Wt. 570.8
B. P. 225°C at 1 mm
Flash P. 430°F (C.O.C.)
Density 0.983 @25°/25°C
Toxicity: Details unknown; probably low.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

ACID CARBOYS, EMPTY
Warning: These containers may contain concentrated vapors or even some liquid acid remaining from their original contents. Therefore, they can give rise to all the hazards of their original contents.
Shipping Regulations:
I. C. C. Classification: See Section 11, §73.29 (c).
Coast Guard Classification: Hazardous article.

ACID LIQUIDS, N.O.S. See Corrosive Liquids.
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

ACID, SPENT, or ACID, SLUDGE.
See Nitric Acid, Sulfuric Acid.
Shipping Regulations: Section 11.

Coast Guard Classification:
Corrosive liquid; white label.

ACONITE

Synonyms: Monkshood; aconitum; wolfsbane.

Description: The dried tuberous root of Aconitum Napellus, composed of several alkaloids, the chief one being aconitine.

Toxic Hazard Rating:
- Acute Local: Ingestion 3; Inhalation 3
- Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
- Chronic Local: U
- Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2

Toxicology: The poisonous alkaloid can be absorbed through the skin sufficiently to cause death. Usually causes pupils to dilate, but may cause them to be contracted. A lethal dose causes diminution in force and frequency of pulse, a cold and clammy skin and a tingling and numbness of the mouth, face and throat. Somewhat larger doses cause burning of the throat and stomach, increased salivation, nausea, retching and vomiting, grinding of the teeth and extension of the numbness and tingling to other parts of the body. There is difficulty in swallowing and speaking and pain in eyes and head. The fatal period is from 8 minutes to 3 or 4 hours.

Treatment and Antidotes: Wash stomach with tannic acid or powdered charcoal. Heart stimulants, such as strong coffee or caffeine. Artificial respiration and oxygen if necessary. Keep patient warm. Call a physician.

Fire Hazard: Slight, when exposed to heat or flame (Section 6).

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

ACONITIC ACID

Synonym: 1, 2, 3-Propenetricarboxylic acid.

Description: White crystalline powder.

Formula: $HOOCCHC(COOH)CH_2$-COOH

Constants:
- Mol. Wt. 174.11
- M. P. 195°C (decomp.)

Toxicity: Unknown

Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).

Storage and Handling: Section 7

ACONITINE

Synonym: Acetyl benzoyl aconine.

Description: White crystalline alkaloid; feeble bitter taste.

Formula: $C_{34}H_{49}NO_{11}$

Constants:
- Mol. Wt. 647.74
- M. P. 188 - 197.8°C

Toxic Hazard Rating:
- Acute Local: Ingestion 3; Inhalation 3
- Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
- Chronic Local: U
- Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2

Toxicology: This intensely poisonous alkaloid can be absorbed through the skin to cause death. Ingestion in small quantities may affect the eyes and cause blindness. Its toxicity is about equal to that of aconite.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

ACONITINE DIACETYL. See Aconitine.

ACONITINE HYDROBROMIDE. See Aconitine.

ACONITINE HYDROCHLORIDE. See Aconitine.

ACONITINE NITRATE
Description: Crystals.
Formula: $C_{34}H_{49}NO_{11}\cdot HNO_3\cdot 5H_2O$
Constant:
  Mol. Wt. 800.84
Toxicity: See Aconitine.
Fire Hazard: Moderate, by spontaneous chemical reaction; an oxidizing agent (Section 6).
Disaster Control: Dangerous; when heated, it emits highly toxic fumes of oxides of nitrogen; can react vigorously with reducing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ACONITINE SULFATE. See Aconitine.

ACONITUM FEROX
Synonyms: Bish; visha; Indian aconite.
Toxicity: Most powerful poison of the aconites. See also Aconite.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ACRIDINE
Description: Small colorless needles.
Formula: $C_{13}H_9N$
Constants:
  Mol. Wt. 179.21
  M. P. 110.5°C
  B. P. 346°C
  Density 1.1005 @19.7°/4°C
  Vap. Press. 1 mm @129.4°C
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Toxicology: Occasional injuries stem from its industrial use either as a solid or as a vapor. Is strongly irritating to the skin and mucous surfaces. Upon inhalation it causes sneezing, itching or even violent burning of the skin; sometimes even inflammatory swelling. It is regarded as the effective irritant in tar and creosote or pitch, etc., which can sensitize the skin to light (Section 9).
Disaster Control: Moderately dangerous; when heated to decomposition, emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ACROLEIN
Synonyms: Propenal; acrylic aldehyde; allyl aldehyde; acraldehyde.
Description: Colorless or yellowish liquid; disagreeable choking odor.
Formula: CH_2CHCHO
Constants:
  Mol. Wt. 56.06
  M. P. −87.7°C
  B. P. 52.5°C
  Flash P. < 0°F
  Density 0.841 @20°/4°C
  Autoign. Temp. Unstable (532°F)
  Vap. D. 1.94
Toxic Hazard Rating:
  Acute Local: Irritant 3; Allergen 1; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: 0
MAC: (ACGIH accepted); 0.5 parts per million in air; 11 milligrams per cubic meter of air.
Toxicology: Due to its extreme lachrymatory effect it serves as its own warning agent. Industry records one fatality ascribed to exposure to it formed by the heat of welding in an enclosed space. It affects particularly the membranes of the eyes and respiratory tract. It is a weak sensitizer; inhalation may cause asthmatic reaction (Section 9).
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide or dry chemical (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when

heated to decomposition, emits highly toxic fumes; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

ACRYLAMIDE

Description: White crystalline solid.
Formula: $CH_2CHCONH_2$
Constants:
Mol. Wt. 71.08
M. P. 84.5 ± 0.3°C
B. P. 125°C @ 25 mm
Density 1.122 @ 30°C
Vap. Press. 1.6 mm @ 84.5°C
Vap. D. 2.45
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Toxicology: This material is dangerous because it can be absorbed through the unbroken skin. From animal experiments it would seem that its effect is toxic upon the central nervous system. Adult rats fed an average of 30 mg/kg of this material for 14 days were all partially paralyzed and had reduced their food consumption by 50%.
Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ACRYLIC ACID

Synonyms: Propene acid; acroleic acid.
Description: Liquid; acrid odor.
Formula: C_2H_3COOH
Constants:
Mol. Wt. 72.06
M. P. 14°C
B. P. 141°C
Density 1.062
Vap. Press. 10 mm @ 39.0°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Explosion Hazard: Slight, by spontaneous chemical reaction; it polymerizes violently.
Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes; it can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ACRYLONITRILE

Synonyms: Propene nitrile; vinyl cyanide.
Description: Colorless, mobile liquid; mild odor.
Formula: CH_2CHCN
Constants:
Mol. Wt. 53.06
M. P. -82°C
B. P. 78.9°C
Flash P. 32°F (O. C.)
Density 0.797 @ 20°/4°C
Autoign. Temp. 898°F
Vap. Press. 100 @ 22.8°C
Vap. D. 1.83
Toxicity: High. See Cyanides.
MAC: ACGIH(accepted); 20 parts per million in air; 43 milligrams per cubic meter of air.
Toxicology: Acrylonitrile closely resembles hydrocyanic acid in its toxic action. By inhibiting the respiratory enzymes of tissue, it renders the tissue cells incapable of oxygen absorption. Poisoning is acute; there is little evidence of cumulative action on repeated exposure.

Exposure to low concentrations is followed by flushing of the face and increased salivation; further exposure results in irritation of the eyes, photophobia, irritation of the nose, deepened respiration, and, if exposure continues, shallow respiration. Nausea, vomiting, weakness, an oppressive feeling in the chest, and ocasionally headache and diarrhea are other complaints. Several cases of mild jaundice accompanied by mild anemia and leucocytosis have been reported. Urinalysis is generally negative, except for an increase in bile pigment. Serum and bile thiocyanates are raised. See also Hydrocyanic Acid.

Fire Hazard: Dangerous, when exposed to heat or flame.

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride.

Explosion Hazard: Moderate, when exposed to flame.

Explosive Range: 3.05 - 17.0%

Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides; can react vigorously with oxidizing materials.

Ventilation Control (moderate rate): Section 2.

Storage and Handling: Section 7

Shipping Regulations: Section 11.
- I.C.C. Classification: Flammable liquid; red label.
- Coast Guard Classification: Inflammable liquid; red label.
- MCA warning label.

ACTINIC RADIATION

Caution: Outdoor workers such as fishermen, sailors, soldiers and farmers show a high incidence of skin cancer. The commonest acute manifestation of actinic radiation effects on skin is sunburn. See p. 61 and Section 5.

ACTINIUM

Description: Brownish-red granular powder.

Formula: Ac

Constants:
- M. P. 1800°C
- At. Wt. 227

Radiation Hazard (Section 5): Actinium is radioactive and has toxic properties common to radioactive materials. Natural isotope Ac-228 (Mesothorium-2); half life 6.13 hours; emits beta particles of 1.55 mev and many gamma rays between 0.06-0.97 mev. See also Ra-228.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

ACTIVATED CARBON

Synonym: Charcoal.

Description: Black amorphous mass.

Formula: C

Constants:
- M. P. > 6300°F
- B. P. 7600°F
- Density 3.51
- At. Wt. 12.01

Toxic Hazard Rating:
- Acute Local: Irritant 1; Allergen 1
- Acute Systemic: 0
- Chronic Local: Irritant 1; Allergen 1
- Chronic Systemic: 0

Caution: Pure carbon is nontoxic. However, activated carbon, usually made from organic matter, is frequently found associated with small amounts of irritating and possibly toxic impurities. Avoid wetting and subsequent drying in storage. Store with ventilation. See also Coal Tar.

Fire Hazard: Slight, when exposed to heat or flame.

Spontaneous Heating: Yes

To Fight Fire: Water (Section 6).

Explosion Hazard: Slight, when dust is exposed to flame. (See Dust Explosions)

Personal Hygiene: Section 3

ADHESIVE PLASTER

Synonym: Adhesive Tape.

Toxic Hazard Rating:
- Acute Local: Allergen 1
- Acute Systemic: 0
- Chronic Local: Irritant 1; Allergen 1
- Chronic Systemic: 0

Caution: The reaction may be of allergic nature, manifested as itching and burning of the skin with redness and blister formation (Section 9).

Fire Hazard: Slight; when heated, emits acrid fumes (Section 6).

Storage and Handling: Section 7

ADIPIC ACID
Synonyms: Hexane dioic acid; 1,4-butane dicarboxylic acid.
Description: Fine white crystals or powder.
Formula: $COOH(CH_2)_4COOH$
Constants:
Mol. Wt. 146.14
M. P. 152°C
B. P. 337.5°C
Flash P. 385°F (C.C.)
Density 1.360 @25°/4°C
Vap. Press. 1 mm @159.5°C
Vap. D. 5.04
Toxicity: Details unknown; probably slight.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ADIPONITRILE
Synonyms: 1,4-Dicyanobutane; tetramethylene cyanide.
Description: Water-white liquid; practically odorless.
Formula: $CN(CH_2)_4CN$
Constants:
Mol. Wt. 108.14
M. P. 2.3°C
B. P. 295°C
Flash P. 199.4°F (O.C.)
Density 0.965 @20°/4°C
Vap. D. 3.73
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
Toxicology: It is toxic since the nitrile group will behave as a cyanide when ingested or absorbed in the body by contact. It produces distrubances of the respiration and circulation, irritation of the stomach and intestines, and loss of weight. Its low vapor pressure at room temperature makes exposure to harmful concentrations of its vapor unlikely if handled with reasonable care in well ventilated areas. Combustion products of adiponitrile may contain hydrocyanic acid. Accordingly, fires involving this material may be hazardous from a toxicological standpoint. See also Hydrocyanic Acid and Nitriles.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

"ADRENALINE"
Synonym: Epinephrine.
Description: Light brown or nearly white crystals.
Formula: $C_6H_3(OH)_2CHOHCH_2NHCH_3$
Constants:
Mol. Wt. 183.3
M. P. 211 - 212°C
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: Ingestion 0; Inhalation 2; Skin Absorption 3
Chronic Local: Allergen 1
Chronic Systemic: Ingestion 1; Inhalation 1; Skin Absorption 1
Toxicology: May cause pallor, tremor, anxiety, nervousness, rapid, forceful pulse, rise in blood pressure and temperature, rapid breathing, dilation of the pupils. Allergic skin reactions have been known to result from contact causing contact dermatitis (Section 9).
Treatment and Antidotes: Guanine or atropine may be helpful. Usually the symptoms are of short duration and clear up spontaneously.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Ventilation Control (normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

AIR (LIQUID AND COMPRESSED)
Description: Bluish, mobile liquid.

Formula: $O_2 + N_2$
Constants:
B. P. −189°C (liquid)
Flash P. None
Autoign. Temp. None
Caution: Liquid air exists at so low a temperature that contact with it will destroy tissue. Personnel employed in areas of compressed air may develop caisson disease (the bends, the chokes) if decompression is too rapid.
Explosion Hazard: Moderate when containers under pressure are shocked or exposed to heat or flame. Flammable materials which have been in contact with liquid air may explode very easily. Ordinary oxidation is greatly accelerated in compressed air (Section 7).
Disaster Control: Moderately dangerous; due to shock it can shatter the compressed gas container with explosive force; can react vigorously with reducing materials.
Storage and Handling: Section 7
Shipping Regulations: See Air, Compressed.

AIR, COMPRESSED
Shipping Regulations: Section 11.
I. C. C. Classification: Nonflammable gas; green label.
Coast Guard Classification: Nonflammable gas; green gas label.

AIRPLANE FLARES. See Explosives, low.

ALCOHOL, DENATURED
Synonym: Denatured spirits.
Description: Liquid.
Composition: Alcohol and denaturants.
Toxicity: This will depend upon the alcohol in question (generally ethyl alcohol) plus the denaturants used. Some denaturants are allergens which can produce contact dermatitis or asthma upon ingestion (Section 9).
Fire Hazard: Dangerous; when heated it emits acrid fumes; can react vigorously with oxidizing materials (Section 6).
Explosion Hazard: Moderate. See Ethyl Alcohol.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: See Alcohol or Alcohol, N. O. S.
Coast Guard Classification: Inflammable liquid; red label.

ALCOHOLS, N. O. S. (See specific compound)
Description: A generic term applied to a series of compounds, the simplest of which has the general formula $C_nH_{2n+1}OH$.
Toxicity: No general statement can be made as to the toxicity of alcohols, due to wide differences in toxic effects. When the term "alcohol" is used alone it usually applies to ethyl alcohol (C_2H_5OH), which is relatively nontoxic when compared with methyl and some other alcohols.
Fire Hazard: Dangerous; when exposed to heat or flame, will burn readily and emit acrid fumes (Section 6).
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

ALCOHOL, TERTIARY (See specific compound)
Shipping Regulations: Section 11.
I. C. C. Classification: See Alcohol or Alcohol, N. O. S.
Coast Guard Classification: Inflammable liquid; red label.

ALDEHYDE AMMONIA
Synonym: Acetaldehyde ammonia; 1-aminoethanol.
Description: White crystalline solid.
Formula: $CH_3CH(NH_2)OH$
Constants:
Mol. Wt. 61.08
B. P. 100°C
M. P. 97°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U

Chronic Systemic: Ingestion 2; Inhalation 2
Fire Hazard: Moderate when exposed to heat or flame; readily decomposes into acetaldehyde and ammonia when heated (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: See Ammonia
Disaster Control: Moderately dangerous; when heated to decomposition emits toxic fumes; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALDEHYDES. (See also specific compounds.)
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 1
Chronic Local: U
Chronic Systemic: Ingestion 1; Inhalation 1
Toxicology: All the aldehydes possess anaesthetic properties, but this is obscured by their highly irritant action on the eyes and mucous membranes of the respiratory tract. The lower aldehydes, very soluble in water, act chiefly on the eyes and tissues of the upper respiratory tract. The higher aldehydes, less soluble in water, tend to penetrate more deeply into the respiratory system and may affect the lungs.

ALDOL
Synonyms: Acetaldol; 3-butanolal; oxybutyric aldehyde.
Description: Clear, white to yellow water; syrupy liquid.
Formula: $CH_3CH(OH)CH_2CHO$
Constants:
Mol. Wt. 72.10
B. P. 182°C
Flash P. 181°F (C.C.)
Density 1.11
Autoign Temp. 530°F
Vap. D. 3.04
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; it decomposes into crotonaldehyde and water when heated (see Crotonaldehyde).
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of crotonaldehyde; can react with oxidizing materials.
Ventilation Control (normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALDRIN
Synonyms: 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-dimethanonaphthalene.
Description: Crystals.
Formula: $C_{12}H_8Cl_6$
Constants:
Mol. Wt. 365
M. P. Not less than 90°C; up to 100 - 101°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 2
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
MAC: ACGIH (tentative); 0.25 milligrams per cubic meter of air.
Toxicology: Ingestion, inhalation or absorption of this material into the body causes irritability, convulsions and depression in from 1 to 4 hours. Continued exposure to it causes liver damage.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene and hydrogen chloride.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1

Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Poison B; poison label.

ALFALFA MEAL

Toxicology: A mild sensitizer, which when inhaled may cause asthma, running nose, sneezing, coughing and tearing eyes (Section 1). Contact with skin may cause contact dermatitis (Section 9).
Fire Hazard: Moderate, when exposed to heat or flame; by spontaneous chemical reaction (Section 6).
Spontaneous Heating: Yes
Caution: Avoid moisture content extremes. Fires may smolder for 72 hours before becoming noticeable.
Storage and Handling: Section 7

ALIZARIN

Synonyms: 1, 2-Dihydroxyanthraquinone.
Description: Orange-red crystals.
Formula: $C_6H_4(CO)_2C_6H_2(OH)_2$
Constants:
Mol. Wt. 240.2
B. P. 430°C (sublimable)
M. P. 289°C
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALIZARIN 778

Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight; when heated it emits acrid fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALIZARIN RED 1034

Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALIZARIN SULFATE. See Alizarin Red 1034.

ALKALINE CAUSTIC LIQUID, N.O.S.

Synonym: Caustic alkali solution.
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 2
Acute Systemic: U
Chronic Local: Irritant 2
Chronic Systemic: U
Ventilation Control (use optional): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Shipping Regulations: Section 11.
I.C.C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

ALKALINE CORROSIVE BATTERY FLUID. See Alkaline Caustic Liquid, N.O.S.

ALKALIES (See also specific compounds.)

Description: A term loosely applied to the hydroxides and carbonates of the alkali metals, alkaline earth metals as well as the bicarbonate and hydroxide of ammonium. They can neutralize acids, change the color of indicators and impart a soapy taste and feel to aqueous solutions.
Toxicity: Variable
Toxicology: The alkalies, as a group, constitute one of the commonest causes of occupational dermatitis. They act on the skin as primary irritants. Alkaline solutions soften and dissolve the keratin layer, and the skin becomes white, soggy, wrinkled and macerated. Repeated exposure frequently results in the development of chronic eczematous skin conditions (Section 9). The stronger caustics may produce chemical burns which are often deep and slow in healing.

Systemically, the only alkali presenting any hazard is ammonia.

ALKALIES, N.O.S. See Sodium Hydroxide.

ALKALINE CORROSIVE LIQUID, N.O.S. See Alkaline Caustic Liquids, N.O.S.

ALKALOID SALTS

Synonym: Alkaloids.
Toxic Hazard Rating:
- Acute Local: Allergen 1
- Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 1
- Chronic Local: Irritant 1; Allergen 1
- Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 1

Toxicology: Practically all of the alkaloid salts are poisonous. Some of them also cause allergic symptoms in humans, such as contact dermatitis or asthma. See specific alkaloid salt (Section 9).
Disaster Control: Dangerous; when heated they emit highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ALKANESULFONIC ACID, MIXED

Description: Liquid.
Constants:
- M. P. −40°C
- B. P. 248°F
- Density 1.38

Toxicity: Details unknown; probably moderately toxic.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

ALKYL ARYL POLYETHYLENE GLYCOL ETHER

Description: Liquid.
Constants: B. P. 302°F
- Flash P. 440°F
- Density 1.06

Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ALKYL DIMETHYL BENZYL AMMONIUM CHLORIDE

Synonym: BTC
Description: Clear, mobile liquid.
Formula $C_6H_5CH_2N(CH_3)_2RCl$
Constants: Mol. Wt. 365
- Density 0.9884 @ 20°C (50%)

Toxic Hazard Rating:
- Acute Local: Irritant 1; Ingestion 1
- Acute Systemic: Ingestion 1; Inhalation 1
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Slight; when heated, emits acrid fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALKYL MERCURIACETATES. See Mercury Compounds, Organic.

ALKYL PHENYL POLYETHYLENE GLYCOL ETHER

Description: Liquid.
Constants:
- M. P. 23°F (approx.)
- Density 1.0643 @ 20°/20°C
- Autoign. Temp. 590°F

Toxic Hazard Rating:
- Acute Local: Irritant 1
- Acute Systemic: Ingestion 2; Inhalation 1; Skin Absorption 1
- Chronic Local: Irritant 1
- Chronic Systemic: Ingestion 1; Inhalation 1; Skin Absorption 1

Toxicology: Water solutions of less than 1% of this material have irritating properties comparable to soap. Before this material is used in foods or drug preparations a complete physiological evaluation of it in its intended use should be made. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (normal rate):

Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALLETHRIN

Synonyms: dl-2-allyl-4-hydroxy-3-methyl-2-cyclopenten-1-one ester of cis and trans-dl-chrysanthemummono-carboxylic acid.
Description: Viscous liquid.
Formula: $C_{19}H_{26}O_3$
Constant:
Mol. Wt. 302.4
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: Ingestion 1; Inhalation 1
Chronic Local: Allergen 1
Chronic Systemic: Ingestion 1; Inhalation 1
Toxicology: It can cause liver and kidney damage by all routes of entry into the body. Lung congestion may occur due to exposure. Local contact may cause contact dermatitis. Inhalation may cause asthma, coughing, wheezing, running nose and eyes (Section 9).
Fire Hazard: Slight; when heated, emits acrid fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALLICIN

Description: Colorless oily liquid; sharp garlic odor.
Formula: $C_6H_{10}OS_2$
Constants:
Mol. Wt. 162.3
Density 1.112 @ 20°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Slightly dangerous; when heated to decomposition it emits toxic fumes.
Ventilation Control (normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALLOXANTIN

Synonym: Uroxin.
Description: Crystalline powder; on exposure to air turns red; yellow at 225°C
Formula: $C_8H_6N_4O_8 \cdot 2H_2O$
Constant:
Mol. Wt. 322.19
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2
Chronic Local: U
Chronic Systemic: Ingestion 2
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALLSPICE

Synonym: Pimenta.
Composition: Eugenol, etc.
Toxicology: A weak sensitizer which may cause dermatitis on local contact (Section 9).
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

ALLYL ACETATE

Description: Liquid.
Formula: $CH_3CO_2CH_2CHCH_2$
Constants:
Mol. Wt. 100.1
Vap. D. 3.45
Toxicity: Details unknown. Allyl compounds are generally toxic.
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

ALLYL ACETONE

Synonym: 5-hexen-2-one
Description: Colorless liquid.
Formula: $CH_2CHCHCH_2COCH_3$
Constants:
Mol. Wt. 98.1
B. P. 129.5°C
Density 0.841 @ 20°/20°C
Vap. D. 3.39
Toxicity: Details unknown. Allyl compounds are generally toxic.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ALLYL ALCOHOL

Synonym: 2-Propen-1-ol
Description: Limpid liquid; pungent odor.
Formula: CH_2CHCH_2OH
Constants:
  Mol. Wt. 58.08
  M. P. −129°C
  B. P. 96 - 97°C
  Flash P. 70°F (C.C.)
  Density: 0.854
  Autoign. Temp. 713°F
  Vap. Press. 10 mm @10.5°C
  Vap. D. 2.00
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 2
  Chronic Local: U
  Chronic Systemic: U
MAC: ACGIH (tentative); 5 parts per million in air.
Toxicology: It is a toxic irritant very dangerous to the eyes and readily absorbed through the skin.
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 3.0 - 18.0%
Disaster Control: Dangerous; when heated, it emits toxic fumes; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.
  MCA warning label.

ALLYL ALDEHYDE. See Acrolein.

ALLYL AMINE

Synonym: 2-propenylamine.
Description: Colorless liquid.
Formula: $CH_2CHCH_2NH_2$
Constants:
  Mol. Wt. 57.09
  B. P. 53.2°C
  Density 0.761 @20°/4°C
  Autoign. Temp. 705°F
  Vap. D. 2.00
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 2
  Chronic Local: U
  Chronic Systemic: U
Toxicology: In animal experiments, inhalation produced irritation of nose and mouth, congestion of the eyes, irregular respiration, cyanosis, excitement, convulsions, coma and death. Extraordinary precautions against fumes is advised.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALLYL AMINE, ANHYDROUS.

See Allyl Amine.

ALLYL BROMIDE

Description: Colorless liquid.
Formula: CH_2CHCH_2Br
Constants:
  Mol. Wt. 121.0
  M. P. −119.4°C
  B. P. 71.3°C
  Flash P. 30°F
  Density: 1.3980 @20°/4°C
  Autoign. Temp. 563°F
  Vap. D. 4.17
Toxicity Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 2
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame.

To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of carbonyl bromide and hydrogen bromide; can react vigorously with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

Shipping Regulations: Section 11.

I. C. C. Classification: Flammable liquid; red label.

Coast Guard Classification: Inflammable liquid; red label.

ALLYL CHLORIDE

Synonym: 3-Chloropropene.

Description: Colorless liquid.

Formula: CH_2CHCH_2Cl

Constants:

Mol. Wt. 76.53

M. P. -136.4°C

B. P. 44.6°C

Flash P. -25°F

Density 0.938 @ 20°/4°C

Autoign. Temp. 737°F

Vap. D. 2.64

Toxic Hazard Rating:

Acute Local: Irritant 3; Ingestion 3; Inhalation 3

Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 2

Chronic Local: U

Chronic Systemic: U

Toxicology: The vapors of allyl chloride are quite irritating to the eyes, nose and throat and contact of the liquid with the skin, in addition to local vasoconstriction and numbness, may lead to rapid absorption and distribution through the body. If remedial measures are not taken promptly, such contact may result in burns and internal injuries. Inhalation may cause headache, dizziness, and in high concentration, loss of consciousness; however, even in low concentration, its odor and irritating effects furnish warning of its presence in most cases. Concentrations of the vapors high enough to cause serious effects, including damage to the lungs, especially on repeated exposure, may not be intolerable. Consequently, the warning characteristics should never be disregarded. In general, precautions should be taken at all times to avoid spillage and accumulation of noticeable concentrations of the vapors in the atmosphere.

Treatment and Antidotes:

1. Upon contact of liquid with skin or clothes:

(a) Remove immediately any clothing wet or even slightly splashed and wash allyl chloride off skin at once, using soap and a shower bath. Do not delay for any reason. Do not use organic solvents for washing, as they may increase the rate of penetration.

(b) Treat exposed area as a burn. Even if there is no redness, cover the area liberally with a good burn ointment; keep the part dry and renew ointment daily until all symptoms have subsided.

(c) If burn is severe, or if there is any question regarding its severity, call a physician (see item 4 below).

(d) Muscular pain, which may be noted at the site of skin penetration, can be relieved by the intravenous injection of a soluble calcium salt (e. g., 10 ml. of 10% calcium gluconate).

2. Contact of liquid or vapor with eyes (symptoms: burning, redness, pain):

(a) Immediately wash eyes with copious amounts of clean water.

(b) Bathe eye thoroughly with normal saline solution (8 gm. sodium chloride per liter of distilled water).

(c) Instill one drop of an ophthalmic local anesthetic (pontocaine) in each eye for relief of pain. Pad if necessary; dark glasses if necessary; rest.

3. Entrance of liquid into mouth:

(a) Immediately wash mouth out with copious amounts of water.

(b) Immediately administer white of egg or other emollient, and as soon as possible follow with 5% saline solution or other mild emetic. In any case take patient to emergency hospital or physician at once, using stretcher and vehicle so that patient will avoid exertion.

It is preferable that internal treatment (other than the first aid measures in item 3b) be administered by a physician. The following is the advice of the Shell Chemical Co.: "The most serious type of respiratory difficulty that may be encountered is pulmonary edema arising from the irritation of the lung alveoli. Though no cases of a serious nature have been encountered to date, treatment of serious lung irritation, if it should occur, should include use of oxygen (50-60%), bed rest, and administration of an atropine derivative. If toxic systemic reactions occur in an individual, it seems wise to induce mild alkalinization, and to force fluids, so as to reduce injury to the kidneys to a minimum. It also seems wise to promote protection to the liver by administration of alkaline-buffered salt and glucose solutions in order to build up the general alkaline reserves, and to further protect the liver by the use of intravenous injections of amino-acid preparations containing high quantities of methionine, and the adoption of a high protein, low-fat diet. In general, the maintenance of the optimal nutritional state is desirable."

4. General comments:

(a) Treat every exposure; do not assume that any exposure is insignificant.

(b) Do not underestimate extent of injury from any exposure. Reactions may be slow, but when left without care, can become painful and complicated.

(c) Clothing wet with allyl chloride should be washed before re-use.

Storage and Handling: Keep away from heat, radiators and sunlight. Dry allyl chloride can be stored in steel for long periods without appreciable corrosion. Experiments show that cast iron, 18-8 stainless steel, monel, "Inconel," nickel, "Hastelloy AB," stoneware and red brass are corroded less than 0.020 inch per year at storage temperatures. Aluminum, however, is corroded more than 0.05 inch per year by dry allyl chloride under similar conditions. When allyl chloride contains more than a trace of water, corrosion of carbon steel becomes appreciable and localized attack is frequently observed. This is due to the hydrogen chloride evolved during hydrolysis. Keep the liquid off the skin and clothes. Where danger of spillage upon the body may exist, workers should wear rubber gloves, goggles, aprons, and/or other protective clothing to avoid the consequences of spilling or splashing allyl chloride. Anti-splash face masks are also recommended. Gloves made of materials which can be wet through, such as untreated canvas, are useless. Maintain good ventilation. Work in a fume hood or with closed system if possible; otherwise, use enough ventilation so that the odor of allyl chloride does not persist. If it should be necessary to enter an area in which the odor of allyl chloride is at all noticeable, use a gas mask equipped with an "organic vapor" canister. Do not disregard the warning odor or eye irritation of allyl chloride. See also Section 7.

Fire Hazard: Highly dangerous, when exposed to heat or flame.

To Fight Fire: Carbon dioxide, dry chemical, carbon tetrachloride or water spray (Section 6).

Explosion Hazard: Moderate, when exposed to flame.

Explosive Range: 3.28 - 11.15%

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; it can react vigorously with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3
First Aid: See "Treatment and Antidotes" above.
Shipping Regulations: Section 11.
MCA warning label.

ALLYL CHLOROCARBONATE

Synonym: Allyl chloroformate.
Description: Liquid.
Formula: CH_2CHCH_2OCOCl
Constants:
Mol. Wt. 120.5
B. P. 106 - 114°C
Flash P. 88°F (C.C.)
Density 1.14
Vap. D. 4.2
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes of phosgene; it can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

ALLYL CHLOROFORMATE. See Allyl Chlorocarbonate.

ALLYL CHLOROPHENYL CARBONATE

Toxicity: Details unknown; herbicide. Allyl compounds are generally toxic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene.
Storage and Handling: Section 7

ALLYL CYANIDE

Synonym: Vinylacetonitrile.
Description: Colorless liquid.
Formula: CH_2CHCH_2CN
Constants:
Mol. Wt. 67.1
B. P. 116 - 119°C
Density 0.8318 @ 20°/4°C
Toxicity: Highly toxic. See Cyanides.
Disaster Control: Dangerous; emits highly toxic fumes when heated to decomposition or on contact with acids or acid fumes.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALLYL DIGLYCOL CARBONATE

Description: Liquid.
Constants:
B. P. 324°F
Flash P. 378°F
Density 1.14
Toxicity: Details unknown. The allyl compounds are generally toxic.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ALLYLENE

Synonym: Propyne.
Description: Gas
Formula: CH_3CCH
Constants:
Mol. Wt. 40.06
M. P. −104.7°C
B. P. −23.3°C
Density 1.787 g/l @0°C
Vap. D. 1.38
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Inhalation 2
Chronic Local: 0
Chronic Systemic: U
Toxicology: This compound is a simple anesthetic and in high concentrations is an asphyxiant.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or water spray (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 1.74% (L.E.L.)
Disaster Control: Moderately

dangerous; shock can shatter the compressed gas container with explosive force; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

ALLYL ETHER

Synonym: Diallyl ether.
Description: Liquid.
Formula: $(CH_2CHCH_2)_2O$
Constants:
Mol. Wt. 98.1
B. P. 94.3°C
Density 0.805
Vap. D. 3.38
Toxicity: Details unknown. Allyl compounds are generally toxic.
Fire Hazard: Moderately dangerous; when heated, it emits acrid fumes; it can react with oxidizing materials.
Storage and Handling: Section 7

ALLYL FLUORIDE

Synonym: 3-Fluoropropene.
Description: Colorless gas.
Formula: CH_2CHCH_2F
Constants:
Mol. Wt. 60.07
B. P. −10°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Ingestion 3
Chronic Systemic: Ingestion 2; Inhalation 2
MAC: ACGIH (accepted); 2.5 milligrams as fluoride per cubic meter of air; 1 part per million in air.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ALLYL GLYCERYL ETHER

Synonym: 1-Allyloxy-2,3-epoxypropane.
Formula: $CH_2CHCH_2OCH_2CHOCH_2$
Constants:
Mol. Wt. 114.14
B. P. 153.9°C
Freezing P. −100°C (forms glass)
Flash P. 135°F (O.C.)
Density 0.9698 @20°/4°C
Vap. Press. 21.59 mm @60°C
Vap. D. 3.94
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALLYLIDENE DIACETATE

Description: Liquid.
Formula: $CH_2CHCH(OCOCH_3)_2$
Constants:
Mol. Wt. 158.15
M. P. −36.6°C
B. P. 107°C @50 mm
Flash P. 180°F (O.C.)
Density 1.0749 @20°/20°C
Vap. D. 5.46
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ALLYL IODIDE

Synonym: 3-Iodo propene.
Description: Yellow liquid.
Formula: CH_2CHCH_2I
Constants:
Mol. Wt. 168.0
M. P. −99.3°C
B. P. 103.1°C

Density 1.825 @20°/4°C
Vap. D. 5.8
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of iodine and iodides; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALLYL ISOTHIOCYANATE

Synonym: Allyl mustard oil.
Description: Colorless to pale yellow liquid; irritating odor.
Formula: CH_2CHCH_2NCS
Constants:
Mol. Wt. 99.15
M. P. −80°C
B. P. 150.7°C
Flash P. 566°F
Density 1.013-1.016 @25°/25°C
Vap. Press. 10 mm @38.3°C
Vap. D. 3.41
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: Irritant 1
Chronic Systemic: U
Toxicology: A fumigant. Mild sensitizer and allergen. Local contact may cause contact dermatitis. Inhalation may cause asthma, watery eyes and nose and sneezing (Section 9).
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALLYL MUSTARD OIL. See Allyl Isothiocyanate.

1-ALLYLOXY-2,3-EPOXYPROPANE. See Allyl Glyceryl Ether.

ALLYL PROPYL DISULFIDE

Synonym: Onion oil.
Description: A liquid.
Formula: $C_3H_5S_2C_3H_7$
Constant: Mol. Wt. 148.16
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (tentative): 2 parts per million in air.
Toxicology: This material is particularly irritating to the eyes and respiratory passages.
Fire Hazard: Moderate.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALLYL SULFIDE

Synonym: Allyl disulfide; diallyl disulfide; garlic oil.
Description: A colorless liquid; garlic odor.
Formula: $(CH_2CHCH_2)S_2$
Constants:
Mol. Wt. 114.20
M. P. −83°C
B. P. 139°C
Density 0.888
Toxic Hazard Rating:
Acute Local: Irritant 3;

Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits toxic fumes of oxides of sulfur.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALLYL SULFOCYANIDE

Synonym: Allyl ester thiocyanic acid.
Description: An oil.
Formula: CH_2CHCH_2CNS
Constants:
Mol. Wt. 99.2
B. P. 161° C
Density 1.056 @15°C
Toxicity: Details unknown. The allyl compounds are generally toxic.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides and sulfur.
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALLYL THIOUREA

Synonym: Allyl sulfocarbamide.
Description: White crystalline solid; slight garlic odor; bitter taste.
Formula: $C_3H_5NHCSNH_2$
Constants:
Mol. Wt. 116.1
M. P. 72 - 74°C
Density: 1.22
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3
Acute Systemic: Ingestion 3
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALLYL TRISULFIDE

Synonym: Diallyl trisulfide.
Description: Liquid.
Formula: $(C_3H_5)_2S_3$
Constants:
Mol. Wt. 178.3
B. P. 140°C
Density 1.085 @15°C
Toxicity: Details unknown. The allyl compounds are generally toxic.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

ALMOND OIL

Synonyms: Almond oil expressed; almond oil sweet.
Description: Fixed, non-drying oil; oily liquid.
Composition: Oleic, linoleic, myristic, palmitic acids.
Constant:
Density 0.910 - 0.915 @25°/25°C
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: 0
Chronic Local: Allergen 1
Chronic Systemic: 0
Toxicology: A weak sensitizer. Contact dermatitis may result from local contact (Section 9).
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALMOND OIL, BITTER

Description: Colorless oil, which turns to yellow; bitter almond odor.
Composition: Chief known constituents are benzaldehyde, hydrocyanic acid, benzaldehyde cyanhydrin.
Constants:
B. P. 179°C
Density 1.045 - 1.070 @15°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Toxicology: This material can be

quite toxic if it has not been separated from its hydrogen oyanide. Weak sensitizer; may cause a contact dermatitis (Section 9).
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous in a disaster because when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides, etc.
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALPHA RAYS

Description: Particulate radiation emitted by certain radioactive isotopes. Alpha rays consist of heavy charged particles (helium nuclei) moving at high velocity. See Section 5.
Radiation Hazard: See individual isotopes.

ALUM

Synonym: Potassium aluminum sulfate.
Description: Colorless crystals.
Formula: $KAl(SO_4)_2 \cdot 12H_2O$
Constants:
Mol. Wt. 474.39
M. P. 92.5°C
Density 1.725
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1; Ingestion 1; Inhalation 1
Acute Systemic: 0
Chronic Local: Irritant 1; Allergen 1
Chronic Systemic: 0
Toxicology: A weak sensitizer. Local contact may cause contact dermatitis (Section 9).
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3

ALUMINA

Synonym: Aluminum oxide.
Description: White powder.
Formula: Al_2O_3
Constants:
Mol. Wt. 101.94
M. P. 2050°C
B. P. 2977°C
Density 3.5 - 4.0
Vap. Press. 1 mm @ 2158°C
Toxic Hazard Rating:
Acute Local: Inhalation 1
Acute Systemic: 0
Chronic Local: Inhalation 2
Chronic Systemic: 0
Toxicology: There has been some record of lung damage due to the inhalation of finely divided aluminum oxide particles. However, this effect, known as Shaver's disease, is complicated by the presence in the inhaled air of such things as silica and oxides of iron.
MAC: ACGIH (accepted); 50 million particles per cubic foot of air.
Ventilation Control (use normal rate): Section 2

ALUMINUM

Description: A silvery ductile metal.
Formula: Al
Constants:
At. Wt. 26.97; M. P. 660°C
B. P. 2056°C; Density 2.702
Vap. Press. 1 mm @ 1284°C
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: 0
Chronic Local: Inhalation 1
Chronic Systemic: 0
MAC: ACGIH (accepted); 50 million particles per cubic foot.
Toxicology: There is some controversy concerning the toxicity of aluminum. However, based on the reported literature the possibility cannot be dismissed. Aluminum is not generally regarded as an industrial poison. A form of acute lung fibrosis associated with the manufacture of aluminum powder was discovered in Germany during Wold War II. In 1942 a similar lung disease was discovered independently in Ontario, in connection with the fusing of bauxite in the manufacture of aluminum oxide abrasive materials.
Fire Hazard of Dust: Moderate, when exposed to heat or flame or by chemical reaction.
Spontaneous Heating: No
To Fight Fire: Special mixtures of dry chemical (Section 6).
Explosion Hazard of Dust: Moderate, when exposed to heat or flame.

Ventilation Control (use normal rate): Section 2

ALUMINUM ACETATE
Description: Amorphous white powder.
Formula: $Al(C_2H_3O_2)_3$
Constants:
Mol. Wt. 204.1
M. P. Decomposes
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: 0
Chronic Local: Irritant 1
Chronic Systemic: 0
Toxicology: Weak sensitizer. Local contact may cause contact dermatitis (Section 9).
Personal Hygiene: Section 3

ALUMINUM o-ARSENATE
Description: White powder.
Formula: $AlAsO_4 \cdot 8H_2O$
Constants:
Mol. Wt. 310
Density 3.011
Toxicity: Highly toxic. See also Arsenic Compounds.

ALUMINUM ARSENIDE
Description: A solid.
Formula: AlAs
Constant:
Mol. Wt. 101.9
Toxicity: Highly toxic. See also Arsenic Compounds and Arsine.

ALUMINUM BOROHYDRIDE
Description: Liquid.
Formula: AlB_3H_{12}
Constants:
Mol. Wt. 71.53
B. P. 44.5°C
M. P. −64.5°C
Vap. Press. 400 mm @ 28.1°C
Toxicity: Details unknown. See also Hydrides and Boron Compounds.
Fire Hazard: Dangerous, by spontaneous chemical reaction; ignites spontaneously in air; when heated, it emits toxic fumes.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate; by spontaneous chemical reaction.
Explosive Range: See Hydrogen.
Caution: Evolves hydrogen on contact with water.
Disaster Control: Moderately dangerous; will react with water or steam to produce heat, hydrogen or toxic fumes; can react vigorously with oxidizing materials; can emit toxic fumes on contact with acid or acid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALUMINUM BROMATE
Description: Crystals.
Formula: $Al(BrO_3)_3 \cdot 9H_2O$
Constants:
Mol. Wt. 572.9
M. P. 62.3°C
B. P. Decomposes
Toxicity: Details unknown. See also Bromates.
Fire Hazard: See Bromates (Section 6).
Disaster Control: See Bromates.
Storage and Handling: Section 7

ALUMINUM BROMIDE
Description: White to yellowish-red lumps.
Formula: $AlBr_3$
Constants:
Mol. Wt. 266.73
M. P. 97.5°C
B. P. 263.3°C @ 748 mm
Density 3.0
Vap. Press. 1 mm @ 81.3°C
Toxicity: See Bromides.
Disaster Control: See Bromides
Storage and Handling: Section 7

ALUMINUM CARBIDE
Description: Greenish-gray, pulverized mass.
Formula: Al_4C_3
Constants:
Mol. Wt. 143.91
M. P. Stable to 1400°C
B. P. Decomposes at high temp.
Density 2.36
Toxicity: See Carbides.
Fire Hazard: Moderate, by spontaneous chemical reaction with moisture to liberate methane.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, due to evolution of methane and when exposed to flame.
Disaster Control: Moderately dangerous; will react with water or

steam to produce flammable vapors; on contact with acid fumes, can emit flammable vapors.
Storage and Handling: Section 7

ALUMINUM CHLORATE
Description: Colorless, deliquescent crystals.
Formula: $Al(ClO_3)_3 \cdot 6H_2O$
Constants:
Mol. Wt. 385.4
M. P. Decomposes
Toxicity: Details unknown. See Chlorates.
Fire Hazard: Moderate, by spontaneous chemical reaction; a powerful oxidizer; may ignite upon contact with combustibles (Section 6).
Explosion Hazard: Moderate, when shocked, exposed to heat or by spontaneous chemical reaction with reducing agents.
Caution: When contaminated may become sensitized.
Disaster Control: Moderately dangerous; shock or heat will explode it; when heated to decomposition, emits toxic fumes.
Storage and Handling: Section 7

ALUMINUM CHLORIDE
Description: Yellowish-white granular crystals.
Formula: $AlCl_3$
Constants:
Mol. Wt. 133.35
M. P. 192.4°C
B. P. 180.2°C (sublimes)
Density 2.44
Vap. Press. 1 mm @100.0°C
Toxicity: See Chlorides and Hydrochloric Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of hydrochloric acid; will react with water or steam to produce heat, toxic or corrosive fumes.
Storage and Handling: Section 7

ALUMINUM COMPOUNDS
Most aluminum compounds have little or no toxicity. Exceptions to this rule are found in such substances as aluminum arsenide or aluminum silicofluoride in which the toxic properties are due to the radical which is joined to the aluminum atom.

ALUMINUM DIBORIDE
Description: Hexagonal crystals.
Formula: AlB_2
Constants: Mol. Wt. 48.6
Density 3.19
Toxicity: Details unknown. See also Boron Compounds
Fire Hazard: See Boron Hydrides
Explosion Hazard: See Boron Hydrides
Disaster Control: Dangerous; will react with water or steam to produce toxic fumes; on contact with acid or acid fumes, it can emit toxic fumes.
Storage and Handling: Section 7

ALUMINUM DICHROMATE
Description: Solid.
Formula: $Al_2(Cr_2O_7)_3$
Constant:
Mol. Wt. 702
Toxicity: See Chromium Compounds.
Fire Hazard: See Chromates.
Disaster Control: Slightly dangerous; reacts with reducing materials.
Storage and Handling: Section 7

ALUMINUM DROSS. See Aluminum.
Shipping Regulations: Section 11.
Coast Guard Classification: Inflammable Solid.

ALUMINUM DUST
Synonym: Aluminum powder.
Description: Silvery metallic powder.
Formula: Al
Constants:
Mol. Wt. 26.97
M. P. 660°C
Density 2.708
Toxic Hazard Rating:
Acute Local: Irritant 1; Inhalation 1.
Acute Systemic: 0
Chronic Local: Inhalation 1
Chronic Systemic: 0
Toxicology: This material can irritate the eyes. There are reports in the European literature of chronic pulmonary disease due to the inhalation of aluminum dust. See also Aluminum.

Fire Hazard: Moderate, when exposed to heat or flame or by chemical reaction with oxidizing agents.
To Fight Fire: Special mixtures of dry chemical (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

ALUMINUM FERROCYANIDE
Description: Brown powder.
Formula: $Al_4(Fe(CN)_6)_3 \cdot 17H_2O$
Toxicity: See Ferrocyanides.
Disaster Control: Dangerous, when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes.
Storage and Handling: Section 7

ALUMINUM FLUORIDE
Description: Colorless crystal.
Formula: AlF_3
Constants:
  Mol. Wt. 84
  M. P. 1040°C
  B. P. 1537°C
  Density 3.07
  Vap. Press. 1 mm @1238°C
Toxicity: Highly toxic. See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

ALUMINUM FORMATE
Description: White powder.
Formula: $Al(CHO_2)_3$
Constant:
  Mol. Wt. 162.0
Toxicity: Details unknown. See also Formic Acid.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7.

ALUMINUM FORMOACETATE
Description: White powder.
Formula: $Al(OH)(OOCH)(OOCCH_3)$
Constant:
  Mol. Wt. 148.1
Toxicity: Slight.
Fire Hazard: Slight; when heated, emits acrid fumes.
Storage and Handling: Section 7

ALUMINUM HYDRIDE
Description: Powder.
Formula: AlH_3
Toxicity: Hydrides of some metals such as AsH_3 are extremely toxic; little is known about AlH_3. See also Hydrides.
Fire Hazard: Moderate, by chemical reaction with water or oxidizing agents (Section 6).
Caution: It evolves hydrogen upon contact with moisture.
Explosion Hazard: Severe, by chemical reaction wherein hydrogen gas is produced.
Disaster Control: Moderately dangerous; will react with water or steam to produce heat and hydrogen; reacts with oxidizing materials; on contact with acid or acid fumes, it can emit toxic fumes.
Storage and Handling: Section 7

ALUMINUM IODIDE
Description: White to brown plates.
Formula: AlI_3
Constants:
  Mol. Wt. 407.7
  M. P. 191°C
  B. P. 385.5°C
  Density 3.98 @25°C
  Vap. Press. 1 mm @178.0°C (sublimes)
Toxicity: See Iodides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of iodine.
Storage and Handling: Section 7

ALUMINUM LACTATE
Description: White, yellowish powder.
Formula: $Al(C_3H_5O_3)_3$
Constant:
  Mol. Wt. 294.2
Toxicity: See Aluminum Compounds.
Fire Hazard: Slight; when heated, emits acrid fumes.
Storage and Handling: Section 7

ALUMINUM LIQUID (or PAINT)
Description: Silvery liquid.
Formula: Al in volatile vehicle.
Constant:
  Flash Point 100°F or lower
Toxicity: See Aluminum and vehicle involved.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or

carbon tetrachloride (Section 6).
Explosion Hazard: Moderate.
Disaster Control: Moderately dangerous; when heated to decomposition emits toxic fumes; can react vigorously with oxidizing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

ALUMINUM METHYL

Synonym: Trimethyl aluminum.
Description: Colorless liquid.
Formula: $Al(CH_3)_3$
Constants:
Mol. Wt. 72.07
B. P. 130 °C
M. P. 0 °C
Toxicity: Unknown.
Fire Hazard: Dangerous, by spontaneous chemical reaction with air and reacts violently with water (Section 6).
Explosion Hazard: Moderate, by chemical reaction with air; explodes on contact with water.
Disaster Control: Highly dangerous; shock or heat can shatter the container with explosive force; when heated to decomposition, it emits toxic fumes of alumina; will explode on contact with moisture; reacts vigorously with oxidizing materials.
Storage and Handling: Section 7

ALUMINUM NITRATE

Description: White crystals.
Formula:
$Al(NO_3)_3 \cdot 9H_2O$
Constants:
Mol. Wt. 375.14
B. P. Decomposes @150 °C
M. P. 70 °C
Toxicity: See Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification:
Oxidizing material; yellow label.
Coast Guard Classification:
Oxidizing material; yellow label.

ALUMINUM NITRIDE

Description: White or colorless crystal.
Formula: AlN
Constants: Mol. Wt. 41
M. P. > 2200 °C
B. P. Sublimes @2000 °C
Density 3.26
Toxicity: See Nitrides and Ammonia.
Disaster Control: Slightly dangerous; will react with water or steam to produce toxic or corrosive fumes.
Storage and Handling: Section 7

ALUMINUM OXIDE. See Alumina.

ALUMINUM OXALATE

Description: White powder
Formula: $Al_2(C_2O_4)_3 \cdot 4H_2O$
Constant: Mol. Wt. 390.1
Toxicity: Highly toxic. See Oxalates.

ALUMINUM PAINT. See Aluminum Liquid or Paint

ALUMINUM-1-PHENOL-4-SULFONATE

Description: Reddish-white powder.
Formula: $Al(C_6H_5O_4S)_3$
Constant: Mol. Wt. 546.5
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 1; Ingestion 2; Inhalation 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phenol and oxides of sulfur.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALUMINUM PHENOXIDE

Description: Gray-white powder or crystalline mass.
Formula: $Al(C_6H_5O)_3$
Constants: Mol. Wt. 306.3
M. P. 265 °C (decomp.)
Density: 1.23
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 1; Ingestion 2; Inhalation 2.
Acute Systemic: U
Chronic Local: Irritant 2;

Allergen 1
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of phenol.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALUMINUM PICRATE

Description: A solid.
Formula: $Al(NO_2)_3C_6H_2O)_3$
Constant: Mol. Wt. 771.3
Toxic Hazard Rating:
Acute Local: Allergen 2; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Irritant 2; Allergen 2
Chronic Systemic: Ingestion 3; Inhalation 3
Fire Hazard: Dangerous, by chemical reaction with reducing materials; a powerful oxidizer (Section 6).
Explosion Hazard: Severe, when shocked or exposed to heat. See also Explosives, High.
Disaster Control: Highly dangerous; shock will explode it; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen and explodes; can react vigorously with reducing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALUMINUM PROPOXIDE

Description: White powder.
Formula: $Al(C_3H_7O)_3$
Constants:
Mol. Wt. 204.2
M. P. 106°C
B. P. 248°C
Density 1.058 @20°/0°C
Toxicity: Details unknown. See also Aluminum Compounds and Propyl Alcohol.
Fire Hazard: Slight; when heated, it emits acrid fumes; a combustible material (Section 6).
Storage and Handling: Section 7

ALUMINUM RESINATE

Description: Brown mass.
Formula: $Al(C_{44}H_{63}O_5)_3$
Constant: Mol. Wt. 2042.8
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Storage and Handling: Section 7

ALUMINUM RICINOLEATE

Description: Plastic solid, yellow-brown to dark brown.
Formula: $Al[CO_2(CH_2)_7CHCHCH_2\text{-}CHOH(CH_2)_5CH_3]_3$
Constants:
Mol. Wt. 912
M. P. 95°C
Toxicity: See Aluminum Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

ALUMINUM SODIUM SULFATE

Synonym: Sodium aluminum sulfate.
Description: Colorless crystals.
Formula: $NaAl(SO_4)_2 \cdot 12H_2O$
Constants:
Mol. Wt. 458.29
M. P. 61°C
Density 1.675
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1; Ingestion 1; Inhalation 1
Acute Systemic: 0
Chronic Local: Irritant 1; Allergen 1
Chronic Systemic: 0
Toxicology: A weak sensitizer. Local contact may cause contact dermatitis (Section 9).
Personal Hygiene: Section 3

ALUMINUM SULFATE, DRY

Synonym: Cake alum.
Description: White powder.
Formula: $Al_2(SO_4)_3$
Constants:
Mol. Wt. 342.1
M. P. Decomposes @770°C
Density 2.71
Toxicity: None
Caution: This material hydrolyzes readily to form some sulfuric acid which acts as a tissue irritant, particularly to the lungs. See Sulfuric Acid.

ALUMINUM SULFIDE

Description: Yellowish-gray lumps; odor of hydrogen sulfide.

Formula: Al_2S_3
Constants:
  Mol. Wt. 150.12
  M. P. 1100°C
  B. P. Subl. @1550°C
  Density 2.02
Toxicity: Highly toxic. See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

ALUMINUM SULFOCARBOLATE. See Aluminum-1-Phenol-4-Sulfonate.

ALUMINUM THALLIUM SULFATE

Description: Cubic, octagonal, colorless crystals.
Formula: $AlTl(SO_4)_2 \cdot 12H_2O$
Constants:
  Mol. Wt. 639.7
  M. P. 91°C
  Density 2.32
Toxicity: Highly toxic. See Thallium Compounds.
Disaster Control: See Thallium Compounds.

ALUMINUM TRIETHYL

Synonym: Triethyl aluminum.
Description: Colorless liquid.
Formula: $Al(C_2H_5)_3$
Constants:
  Mol. Wt. 114.15
  B. P. 194°C
  M. P. < -18°C
Toxicity: Details unknown. See also Aluminum.
Fire Hazard: Dangerous, by spontaneous chemical reaction with air; reacts violently with water to evolve ethane (Section 6).
Explosion Hazard: Moderate. See also Ethane.
Disaster Control: Moderately dangerous; will react with water or steam to produce heat and flammable vapors; it can react vigorously with oxidizing materials.
Storage and Handling: Section 7

ALUMINUM TRIMETHYL. See Aluminum Methyl.

ALUMINUM TRIPROPYL

Synonym: Tripropyl aluminum.
Description: Liquid.
Formula: $Al(C_3H_7)_3$
Constant: Mol. Wt. 156.24
Toxic Hazard Rating:
  Acute Local: Irritant 1; Allergen 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Dangerous, by spontaneous chemical reaction with air; can react vigorously with oxidizing materials (Section 6).
Personal Hygiene: Section 3
Explosion Hazard: It hydrolyzes to evolve flammable vapor.
Storage and Handling: Section 7

"ALUNDUM"

Synonym: Alumina
Description: White to dark wine-red, dense, crystalline lumps.
Formula: Al_2O_3
Constant: Mol. Wt. 101.94
Toxic Hazard Rating:
  Acute Local: Inhalation 1
  Acute Systemic: 0
  Chronic Local: Inhalation 2
  Chronic Systemic: 0
MAC: ACGIH (accepted) 50 million particles per cubic foot.
Ventilation Control (use normal rate): Section 2

"ALVAR"

Description: A solid polyvinyl acetal resin.
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Toxicology: Local contact may cause a contact dermatitis (Section 9).
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

ALYPIN

Description: White crystalline powder.
Formula: $C_{16}H_{26}O_2N_2$
Constant: Mol. Wt. 278.4
Toxic Hazard Rating:
  Acute Local: Allergen 1; Ingestion 1; Inhalation 1
  Acute Systemic: U
  Chronic Local: Allergen 1

Chronic Systemic: U
Caution: Poisonings have occurred from small doses but this is very unusual.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Ventilation Control (optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

AMATOL

Description: A high explosive.
Composition: NH_4NO_3: 80%; T. N. T.: 20%
Constant:
  Density 1.47
Toxic Hazard Rating:
  Acute Local: Irritant 2; Allergen 2; Ingestion 2; Inhalation 2
  Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
  Chronic Local: Allergen 2
  Chronic Systemic: Ingestion 3; Inhalation 3
Caution: Local contact may cause contact dermatitis (Section 9).
Fire Hazard: High, as result of spontaneous chemical reaction. A powerful oxidizing mixture (Section 6).
Explosion Hazard: High, due to shock, spontaneous chemical reaction or exposure to flame (Section 7).
Disaster Control: Highly dangerous; emits highly toxic fumes; can react vigorously with oxidizing materials.
Ventilation Control (normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.

AMERICIUM

Description: A metal.
Formula: Am
Constant:
  At. Wt. 241
Toxicity: Americium is radioactive and derives its toxicity from this fact.
Radiation Hazard (Section 5): Artificial isotope Am 241, half-life 490 years; emits alpha particles of 5.45 mev and gamma rays of 0.062 mev. The permissible levels are:
  In body: 0.056 microcurie
  In air: 3×10^{-11} microcurie per milliliter
  In water: 10^{-4} microcurie per milliliter.
Fire Hazard: Unknown

AMBER OIL

Synonym: Oil of amber.
Description: Pale yellow to brown oil, volatile.
Composition: Phenols and terpenes.
Constant: Density 0.85 - 0.92
Toxic Hazard Rating:
  Acute Local; Irritant 1; Allergen 1; Ingestion 1; Inhalation 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Caution: A weak sensitizer. Local contact may cause contact dermatitis (Section 9).
Fire Hazard: Slight, when exposed to heat, it emits acrid fumes (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

AMIDOL

Synonym: Diaminophenol hydrochloride.
Description: Grayish-white crystals.
Formula: $C_6H_8N_2O \cdot 2HCl$
Constant:
  Mol. Wt. 197.07
Toxic Hazard Rating:
  Acute Local: Irritant 1; Allergen 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

"AMINE 220"

Description: Liquid
Formula: $C_{17}H_{33}\underbrace{CNC_2H_4NC}{}_2H_4OH$
Constants:
  Mol. Wt. 350

B. P. 235°C @1 mm
Flash P. 465°F (O.C.)
Density 0.9300 @20°/20°C
Vap. D. 12.1
Toxicity: Details unknown.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

AMINES. See also specific compounds.

A large group of organic compounds, containing nitrogen and considered as being derived from ammonia (NH_3) by replacement of one or more H atoms by an organic radical.

Toxicity: Variable; some are highly toxic, others only slightly.

p-AMINOACETANILIDE

Synonym: Acetyl-p-phenylenediamine.
Description: White to reddish crystals.
Formula: $NH_2C_6H_4NHCOCH_3$
Constant:
Mol. Wt. 150.2
Toxicity: Details unknown. See also p-Phenylene diamine.
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes.
Storage and Handling: Section 7

o-AMINOACETOPHENONE

Synonym: o-Aminoacetylbenzene.
Description: Yellow, oily liquid.
Formula: $CH_3COC_6H_4NH_2$
Constants:
Mol. Wt. 135.2
B. P. 250 - 252°C (slight decomp.)
Toxicity: Unknown
Fire Hazard: Slightly dangerous; when exposed to heat, it emits toxic fumes (Section 6).
Storage and Handling: Section 7

p-AMINOAZOBENZENE

Synonym: p-Phenylazoaniline.
Description: Yellow crystals.
Formula: $C_6H_5NNC_6H_4NH_2$
Constants:
Mol. Wt. 197.2
B. P. > 360°C
M. P. 126°C
Toxicity: Details unknown; an insecticide.
Fire Hazard: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

o-AMINOAZOTOLUENE

Synonym: 2-Amino-5-azotoluene.
Description: Reddish brown to yellow crystals.
Formula: $CH_3C_6H_4N_2C_6H_3NH_2CH_3$
Constants:
Mol. Wt. 225.3
M. P. 99 - 117°C
Toxicity: Details unknown. See also Toluene.
Fire Hazard: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

AMINOAZOTOLUENE HYDROCHLORIDE

Synonym: 2-Amino-5-azotoluene hydrochloride.
Description: Crystals.
Formula: $C_{14}H_{14}N_3 \cdot HCl$
Constant:
Mol. Wt. 260.8
Toxicity: Details unknown. See also Toluene.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

2-AMINOBENZENETHIOL

Synonym: 2-Amino phenyl mercaptan.
Description: Liquid.
Formula: $NH_2C_6H_4SH$
Constants:
Mol. Wt. 125.2
M. P. 23°C
B. P. 227.2°C
Flash P. 175°F
Density: 1.168
Vap. D. 4.3
Toxicity: Details unknown. See also Mercaptans.
Fire Hazard: Moderate, when

exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; can react with oxidizing materials.
Personal Hygiene: Section 3
Storage and Handling: Section 7

p-AMINOBENZOIC ACID

Description: Yellowish to red crystals.
Formula: $NH_2C_6H_4COOH$
Constants:
  Mol. Wt. 137.1
  M. P. 187°C
Toxic Hazard Rating:
  Acute Local: 0
  Acute Systemic: Ingestion 1
  Chronic Local: 0
  Chronic Systemic: Ingestion 1
Fire Hazard: Slight; on decomposition it emits toxic fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

1-AMINOBENZOTHIAZOLE

Description: Crystals.
Formula: $\underbrace{C_6H_4SCNH_2N}$
Constant:
  Mol. Wt. 150.2
Toxicity: Details unknown, but probably toxic.
Disaster Control: Dangerous, when heated to decomposition, it emits highly toxic fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

m-AMINOBENZOTRIFLUORIDE

Description: Colorless liquid with aniline-like odor.
Formula: $H_2NC_6H_4CF_3$
Constants:
  Mol. Wt. 161.13
  M. P. 3°C
  B. P. 189°C
  Density 1.303 @ 15.5°/15.5°C
  Vap. D. 5.56
Toxicity: Details unknown, but probably toxic.
Disaster Control: Dangerous, when heated to decomposition, it emits highly toxic fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-AMINO-1-BUTANOL

Description: Water-white liquid.
Formula: $CH_3CH_2CHNH_2CH_2OH$
Constants:
  Mol. Wt. 89.14
  M. P. -2°C
  B. P. 178°C
  Flash P. 165°F (O.C.)
  Density 0.944 @ 20°/20°C
  Vap. D. 3.06
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water spray, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2-AMINO-4,6-DIMETHYLPYRIDINE

Description: Crystals.
Formula: $C_7H_{10}N_2$
Constants:
  Mol. Wt. 122.17
  B. P. 235.3°C
  M. P. 68.5°C
Toxicity: Unknown
Fire Hazard: Slight; on decomposition it emits toxic fumes.
Storage and Handling: Section 7

p-AMINODIPHENYL

Synonym: Xenylamine; p-biphenylamine.
Description: Colorless crystals.
Formula: $C_6H_5C_6H_4NH_2$
Constants:
  Mol. Wt. 169.2
  M. P. 53°C
  B. P. 302°C
  Density 1.160 @ 20°/20°C
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1; Inhalation 1
  Acute Systemic: Ingestion 1
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Slight; on decomposition it emits toxic fumes.
Ventilation Control (use normal rate) Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

o-AMINOETHYLBENZENE. See o-Ethylaniline.

2-AMINO ETHYL ETHANOL AMINE
Synonym: (2-Hydroxyethyl) ethylenediamine.
Description. Colorless liquid.
Formula: $NH_2CH_2CH_2NHCH_2CH_2OH$
Constants:
Mol. Wt. 104.16
B. P. 243.7°C
Flash P. 265°F (C. C.)
Density 1.0304 @ 20°/20°C
Autoign. Temp. 695°F
Vap. Press. < 0.01 mm @ 20°C
Vap. D. 3.59
Toxicity: Details unknown.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

1-AMINOETHYL-2-HEPTADECYL GLYOXALIDINE
Toxicity: Details unknown; a plant fungicide.
Fire Hazard: Slight; when exposed to heat, it emits acrid fumes.
Storage and Handling: Section 7

N-AMINO ETHYL MORPHOLINE
Description: Liquid.
Formula: $C_2H_4OC_2H_4NC_2H_4NH_2$
Constants: Mol. Wt. 130.2
M. P. 25.6°C
B. P. 204.2°C
Flash P. 175°C (O. C.)
Density 0.9915 @ 20°/20°C
Vap. D. 4.49
Toxicity: Unknown
Fire Hazard: Moderate when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2-AMINO-2-ETHYL-1, 3-PROPANEDIOL
Description: Colorless liquid or solid.
Formula: $CH_2OHC(C_2H_5)NH_2CH_2OH$
Constants:
Mol. Wt. 119.16
M. P. 38°C
B. P. 152°C @ 10 mm
Density 1.099 @ 20°/20°C
Vap. D. 4.11
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

1-AMINO-5-HYDROXYBENZOTHIAZOLE
Description: Crystals.
Formula: $(NH_2)(OH)(C_6H_3)SCN$
Constant:
Mol. Wt. 166.2
Toxicity: Details unknown; probably toxic.
Fire Hazard: Unknown
Disaster Control: Moderate, when heated to decomposition, it emits toxic fumes.
Personal Hygiene: Section 3

1-AMINO-2-METHOXY-4-NITROBENZENE
Synonyms: 4-Nitro-o-anisidine; 5-nitro-2-aminanisole; 2-methoxy-4-nitroaniline.
Formula: $C_6H_3(NO_2)(OCH_3)(NH_2)$
Toxicity: Details unknown. See also Nitrobenzene.
Fire Hazard: Slight.
Disaster Control: Moderate, when heated to decomposition, it emits toxic fumes; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

2-AMINO-4-METHYLPENTANE
Description: Liquid.
Formula: $CH_3CHNH_2CH_2CHCH_3CH_3$
Constants: Mol. Wt. 101.2
B. P. 222.8°C
Flash P. 55°F
Density 0.74
Vap. D. 3.48
Toxicity: Unknown
Fire Hazard: High, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use moderate rate).
Storage and Handling: Section 7

2-AMINO-2-METHYL-1, 3-PROPANEDIOL
Description: Clear liquid.
Formula: $CH_2OHC(CH_3)NH_2CH_2OH$

Constants:
Mol. Wt. 105.14
M. P. 110°C
B. P. 151°C @10 mm
Vap. D. 3.63

Toxicity: Unknown

Fire Hazard: Slight, when exposed to to heat or flame; can react with oxidizing materials (Section 6).

Storage and Handling: Section 7

2-AMINO-2-METHYL-1-PROPANOL

Synonyms: AMP, isobutanolamine.

Description: Colorless liquid.

Formula: $CH_3CH_2NH_2CCH_2OH$

Constants:
Mol. Wt. 89.14
M. P. 30 - 31°C
B. P. 165°C
Flash P. 159°F (Tag. O.C.)
Density 0.934 @ 20°/20°C
Vap. D. 3.04

Toxicity: Details unknown.

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

2-AMINO-3-METHYLPYRIDINE

Description: Liquid.

Formula: $NC_5H_3(CH_3)NH_2$

Constants:
Mol. Wt. 108.08
B. P. 221.1°C
M. P. 33.3°C
Vap. D. 3.73

Toxicity: Details unknown. See also Pyridine.

Fire Hazard: Slight; on decomposition it emits toxic fumes; can react with oxidizing materials (Section 6).

Storage and Handling: Section 7

2-AMINO-4-METHYLPYRIDINE

Description: Crystals.

Formula: $NC_5H_3(CH_3)NH_2$

Constants:
Mol. Wt. 108.08
M. P. 99°C
B. P. 230.9°C
Vap. D. 3.73

Toxicity: Details unknown. See also Pyridine.

Fire Hazard: Slight; on decomposition it emits toxic fumes; can react with oxidizing materials (Section 6).

Storage and Handling: Section 7

2-AMINO-5-METHYLPYRIDINE

Description: Crystals.

Formula: $NC_5H_3(CH_3)NH_2$

Constants:
Mol. Wt. 108.18
M. P. 76.6°C
B. P. 227.1°C
Vap. D. 3.73

Toxicity: Details unknown. See also Pyridine.

Fire Hazard: Slight; on decomposition it emits toxic fumes; can react with oxidizing materials (Section 6).

Storage and Handling: Section 7

2-AMINO-6-METHYLPYRIDINE

Description: Crystals.

Formula: $NC_5H_3(CH_3)NH_2$

Constants:
Mol. Wt. 108.08
M. P. 43.7°C
B. P. 214.4°C
Vap. D. 3.73

Toxicity: Details unknown. See also Pyridine.

Fire Hazard: Slight; on decomposition it emits toxic fumes; can react with oxidizing materials.

Storage and Handling: Section 7

4-AMINO-3-PENTADECYL PHENOL

Synonym: p-Amino hydrogenated cardanol.

Description: Tan-colored, crystalline solid.

Formula: $C_{15}H_{31}C_6H_3(NH_2)OH$

Constants:
Mol. Wt. 319.5
M. P. 99 - 101°C
B. P. 225 - 230°C @1 mm

Toxicity: Unknown

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).

Storage and Handling: Section 7.

p-AMINOPHENOL

Synonyms: Rodinol; ursal P; p-hydroxy aniline.

Description: White powder.

Formula: $NH_2C_6H_4OH$

Constant:
Mol. Wt. 109.1

Toxic Hazard Rating:

- Acute Local: Irritant 1; Allergen 1; Ingestion 1; Inhalation 1
- Acute Systemic: U
- Chronic Local: Allergen 2
- Chronic Systemic: Inhalation 2

Caution: This material resembles p-phenylenediamine. It has reportedly been the cause of contact dermatitis and bronchial asthma (Section 9).

Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.

Ventilation Control: Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

p-AMINOPHENYL CADMIUM DILACTATE

Toxicity: High. See Cadmium Compounds and Phenol.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.

Personnel Protection: Section 3

Personal Hygiene: Section 3

p-AMINOPHENYL MERCURIC LACTATE

Toxicity: Highly toxic. See Mercury Compounds, Organic.

Disaster Control: See Mercury Compounds, Organic.

Storage and Handling: Section 7

3-AMINOPROPANOL

Description: Colorless liquid.

Formula: $H_2NCH_2CH_2CH_2OH$

Constants:

- Mol. Wt. 75.11
- B. P. 168°C @ 500 mm
- Flash P. > 175°F (T.O.C.)
- Freezing P. 12.4°C
- Density 0.9786 gm/cc @ 30°C
- Vap. Press. 2.1 mm @ 60°C
- Vap. D. 2.59

Toxic Hazard Rating:

- Acute Local: Irritant 1; Ingestion 1; Inhalation 1
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Caution: A moderately strong base which, from animal experiments, would seem to be a non-specific irritant.

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Ventilation Control (use optional): Section 2

Personal Hygiene: Section 3

Storage and Handling: Section 7

N-AMINOPROPYL MORPHOLINE

Description: Liquid.

Formula: $\underbrace{C_2H_4OC_2H_4N}_{}C_3H_5NH_2$

Constants:

- Mol. Wt. 144.21
- M. P. −15°C
- B. P. 224.7°C
- Flash P. 220°F (O.C.)
- Density 0.9872 @ 20°/20°C
- Vap. Press. 0.06 mm @ 20°C
- Vap. D. 4.97

Toxicity: Details unknown. See also Morpholine.

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

2-AMINOPYRIDINE

Synonym: alpha-Aminopyridine.

Description: White powder or crystals.

Formula: $C_5H_6N_2$

Constants:

- Mol. Wt. 94.11
- M. P. 58.1°C
- B. P. 210.6°C

Toxic Hazard Rating:

- Acute Local: U
- Acute Systemic: Ingestion 3; Inhalation 3
- Chronic Local: U
- Chronic Systemic: U

Toxicology: A convulsant poison with effects resembling strychnine. In humans the symptoms are headache, weakness, collapse and epileptiform convulsions (Section 1).

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.

Ventilation Control (use moderate rate): Section 2

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

AMINOPYRINE

Synonym: Dimethylaminoantipyrine.
Description: Colorless crystalline powder.
Formula: $C_3ON_3(CH_3)_4C_6H_5$
Constants:
  Mol. Wt. 231.29
  M. P. 107 - 109°C
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: Ingestion 1
  Chronic Local: Allergen 1
  Chronic Systemic: Ingestion 2; Inhalation 2
Caution: Only a small proportion of its users are susceptible to its toxic effects. Mortality in untreated cases is nearly 75 percent. Local contact may cause dermatitis (Section 9).
Disaster Control: Moderately dangerous; When heated to decomposition, it emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

p-AMINOSALICYLIC ACID

Synonym: 4-Amino salicylic acid.
Description: White to brown powder.
Formula: $C_7H_7NO_3$
Constants:
  Mol. Wt. 153.13
  M. P. 147 - 150°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 1; Inhalation 1
  Chronic Local: U
  Chronic Systemic: Ingestion 1; Inhalation 1
Caution: Causes nausea, vomiting, and diarrhea.
Fire Hazard: Slight; on decomposition it emits toxic fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-AMINO-5-SULFANILYLTHIAZOLE

Formula: $C_9H_9N_3O_2S_2$
Constant:
  Mol. Wt. 255.32
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 1; Inhalation 1
  Chronic Local: U
  Chronic Systemic: Ingestion 1; Inhalation 1
Caution: Can cause a transient anemia. Over a period of time thyroid enlargement may occur.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Ventilation Control (optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-AMINOTHIAZOLE

Description: Light brown crystals.
Formula: $C_3H_2NSNH_2$
Constants:
  Mol. Wt. 100.14
  M. P. 90°C
  B. P. Decomposes
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 1; Inhalation 1
  Chronic Local: U
  Chronic Systemic: U
Caution: Believed to cause nausea, headache and general weakness after exposure to from 3-100 mg per cubic meter of air.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

AMIODOXYL BENZOATE

Synonyms: Arthrytin, oxoate.
Description: White odorless, slightly bitter, crystalline powder.
Formula: $C_7H_8INO_4$
Constant:
  Mol. Wt. 297.06
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: Ingestion 1; Inhalation 1
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

AMMONAL
Toxicity: Details unknown, but probably toxic.
Fire Hazard: A powerful oxidizer.
Explosion Hazard: High, when shocked or exposed to heat.
Disaster Control: Highly dangerous; it can explode when shocked or heated; when heated to decomposition it emits toxic fumes; can react vigorously with reducing material.
Storage and Handling: Section 7

AMMONIA-d_3
Synonym: Trideuterio ammonia.
Description: Gas
Formula: ND_3
Constants:
  Mol. Wt. 20.05
  M. P. −74°C
  B. P. −33.4°C
Toxicity: See Ammonia, Anhydrous.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: Moderate, when exposed to flame (Section 7).
Disaster Control: Moderately dangerous; shock can shatter the compressed gas container with explosive force; exposed to heat, it emits toxic fumes; reacts vigorously with oxidizing materials.
Storage and Handling: Section 7.

AMMONIA, ANHYDROUS
Synonym: Ammonia gas.
Description: Colorless gas, extremely pungent odor, liquefied by compression.
Formula: NH_3
Constants:
  Mol. Wt. 17.03
  M. P. −77.7°C
  B. P. −33.35°C
  Density 0.771 g/liter @0°C; 0.817 g/ml @−79°C
  Autoign. Temp. 651°C
  Vap. Press. 10 atm @25.7°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: Irritant 1
  Chronic Systemic: U
MAC: ACGIH (accepted); 100 parts per million in air.
Toxicology: Irritating to eyes and mucous membranes of respiratory tract. Signs and symptoms of exposure are irritation of the eyes, conjunctivitis, swelling of the eyelids, irritation of the nose and throat, coughing, dyspnoea and vomiting. Irritation of the skin may be experienced, especially if it is moist. Corneal ulcers have been reported following splashing of ammonia water in the eye (Section 1).
Fire Hazard: Moderate, when exposed to heat or flame.
Spontaneous Heating: No. Requires high concentrations in air before it catches fire.
To Fight Fire: Carbon dioxide, dry chemical or water spray (Section 6).
Explosion Hazard: Moderate, when exposed to flame. Forms explosive compounds in contact with silver or mercury (Section 7).
Explosive Range: 16.0 - 25.0%
Disaster Control: Moderately dangerous; can shatter the compressed gas container with explosive force; exposed to heat, it emits toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Nonflammable gas; green label.
  Coast Guard Classification: Noninflammable gas; green gas label.
  MCA warning label.

AMMONIA AQUA. See Ammonium Hydroxide.

AMMONIUM ARSENATE
Description: White powder or crystal.
Formula: $(NH_4)_3AsO_4 \cdot 3H_2O$
Constants:
  Mol. Wt. 247.1
  M. P. Decomp. to yield NH_3
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Poison B;

poison label.
Coast Guard Classification: Poison B; poison label.

AMMONIUM m-ARSENITE
Description: White powder.
Formula: NH_4AsO_2
Constant:
Mol. Wt. 125
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

AMMONIUM AZIDE
Description: Colorless plates.
Formula: NH_4N_3
Constants:
Mol. Wt. 60.1
M. P. 160°C
B. P. 133.8°C
Density 1.346
Vap. Press. 1 mm @59.2°C (sublimes)
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate; on decomposition it emits toxic fumes (Section 6).
Explosion Hazard: Moderate, when heated (Section 7).
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

AMMONIUM BENZENE SULFONATE
Description: Crystals.
Formula: $NH_4C_6H_5SO_3$
Constants:
Mol. Wt. 175.2
M. P. 271 - 275°C (decomposes)
Density 1.342
Toxicity: Details unknown, but probably toxic.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

AMMONIUM BIBORATE
Synonym: Ammonium tetraborate.
Description: Colorless, tetragonal crystals.
Formula: $(NH_4)_2B_4O_7 \cdot 4H_2O$
Constants:
Mol. Wt. 263.4
M. P. Decomposes
Toxicity: Details unknown. See also Boron Compounds.

AMMONIUM BICHROMATE
Synonym: Ammonium dichromate.
Description: Yellow needles.
Formula: $(NH_4)_2Cr_2O_7$
Constants:
Mol. Wt. 252.10
M. P. Decomposes before it melts
Density 2.15 @25°C
Toxicity: See Chromium Compounds.
Fire Hazard: Moderate; reacts with reducing agents.
Caution: An oxidizer.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

AMMONIUM BIFLUORIDE
Description: White crystals.
Formula: NH_4FHF
Constants:
Mol. Wt. 57.05
Density 1.21 @12°/12°C (liquid)
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

AMMONIUM BINOXALATE
Description: Colorless crystals.
Formula: $NH_4HC_2O_4 \cdot H_2O$
Constants:
Mol. Wt. 125.08
M. P. Decomposes
Density 1.556
Toxicity: See Oxalates.

AMMONIUM BISULFITE
Synonym: Ammonium hydrogen sulfite.
Description: White crystals.
Formula: NH_4HSO_3
Constants:
Mol. Wt. 99.1
M. P. Decomposes
Toxicity: See Bisulfites.
Disaster Control: See Bisulfites.
Storage and Handling: Section 7

AMMONIUM BROMATE
Description: Colorless crystals.
Formula: NH_4BrO_3
Constants:
  Mol. Wt. 145.96
  M. P. Explodes
Toxicity: See Bromates.
Fire Hazard: See Bromates.
Explosion Hazard: Severe.
Disaster Control: Dangerous.
Storage and Handling: Section 7

AMMONIUM BROMIDE
Description: Colorless, cubic, slightly hygroscopic crystals.
Formula:
  NH_4Br
Constants:
  Mol. Wt. 98.0
  M. P. Sublimes @542°C
  B. P. 396.0°C
  Density 2.429
  Vap. Press. 1mm @198.3°C
Toxicity: See Bromides.
Disaster Control: See Bromides.
Storage and Handling: Section 7

AMMONIUM BROMOPLATINATE
Description: Red-brown, cubic crystals.
Formula: $(NH_4)_2PtBr_6$
Constants:
  Mol. Wt. 710.8
  M. P. 145°C (decomp.)
  Density 4.265
Toxicity: Details unknown. See also Bromides and Platinum Compounds.
Fire Hazard: Slight; on decomposition it emits toxic fumes.
Storage and Handling: Section 7

AMMONIUM BROMOSELENATE
Description: Red octagonal crystals.
Formula: $(NH_4)SeBr_6$
Constants:
  Mol. Wt. 594.5
  Density 3.326
Toxicity: See Selenium Compounds and Bromides.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

AMMONIUM BROMOSTANNATE
Description: Colorless crystals.
Formula: $(NH_4)_2SnBr_6$
Constants:
  Mol. Wt. 634.3
  M. P. Decomposes
  Density 3.50
Toxicity: Details unknown. See also Bromides and Tin Compounds.
Disaster Control: Slightly dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

AMMONIUM CADMIUM CHLORIDE
Description: Crystals.
Formula: $4NH_4Cl \cdot CdCl_2$
Constants:
  Mol. Wt. 397.3
  Density 2.01
Toxicity: See Cadmium Compounds.
Disaster Control: See Cadmium Compounds.
Storage and Handling: Section 7

AMMONIUM CALCIUM ARSENATE
Description: Colorless crystals.
Formula: $NH_4CaAsO_4 \cdot 6H_2O$
Constants:
  Mol. Wt. 305.1
  M. P. 140°C (decomp.)
  Density 1.905
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

AMMONIUM CARBONATE
Synonym: Crystal ammonia.
Description: Colorless, crystalline plates.
Formula: $(NH_4)_2CO_3$
Constant:
  Mol. Wt. 96.09
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1; Inhalation 1
  Acute Systemic: U
  Chronic Local: Irritant 1
  Chronic Systemic: U
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3

AMMONIUM CHLORATE
Description: White crystal or mass.
Formula: NH_4ClO_3
Constant:
  Mol. Wt. 101.6
Toxicity: Details unknown. See also Chlorates.
Fire Hazard: Moderate fire hazard due to spontaneous chemical reaction with reducing agents. A powerful oxidizer. When

contaminated by combustibles it may ignite (Section 6).
Explosion Hazard: High, due to shock, chemical reaction or exposure to heat (Section 7).
Caution: When contaminated it is very sensitive. It can be detonated.
Disaster Control: Highly dangerous; can explode when shocked or exposed to heat; when heated to decomposition, it emits highly toxic fumes; can react vigorously with reducing material.
Storage and Handling: Section 7

AMMONIUM CHLORIDE

Synonym: Sal ammonia.
Description: White crystals.
Formula: NH_4Cl
Constants:
  Mol. Wt. 53.50
  M. P. 520°C
  B. P. 337.8°C
  Density 1.520
  Vap. Press. 1 mm @160.4°C (sublimes)
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1; Inhalation 1
  Acute Systemic: U
  Chronic Local: Irritant 1
  Chronic Systemic: Ingestion 1
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3

AMMONIUM CHLOROAURATE

Description: Yellow crystals.
Formula: NH_4AuCl_4
Constant:
  Mol. Wt. 357.1
Toxicity: See Gold Compounds.

AMMONIUM CHLOROGALLATE

Description: White crystals.
Formula: NH_4GaCl_4
Constants:
  Mol. Wt. 229.6
  M. P. 275°C
Toxicity: Details unknown. See also Gallium Compounds.

AMMONIUM CHLOROIRIDATE

Description: Red-black crystals.
Formula: $(NH_4)_2IrCl_3$
Constants:
  Mol. Wt. 441.9
  M. P. Decomposes
  Density 2.856
Toxicity: Details unknown. See also Iridium Compounds.

AMMONIUM CHLOROIRIDITE

Description: Greenish-brown solid.
Formula: $(NH_4)_3IrCl_3 \cdot 1\frac{1}{2}H_2O$
Constant:
  Mol. Wt. 487
Toxicity: Details unknown. See also Iridium Compounds.

AMMONIUM CHLOROOSMATE

Description: Crystals.
Formula: $(NH_4)_2OsCl_6$
Constants:
  Mol. Wt. 439
  Density 2.93
Toxicity: Details unknown. See also Osmium Compounds.

AMMONIUM CHLOROPALLADATE

Description: Red-brown crystals.
Formula: $(NH_4)_2PdCl_6$
Constants:
  Mol. Wt. 355.5
  M. P. Decomposes
  Density 2.418
Toxicity: Details unknown. See also Palladium Compounds.

AMMONIUM CHLOROPALLADITE

Description: Olive-green crystals.
Formula: $(NH_4)_2PdCl_4$
Constants:
  Mol. Wt. 284.6
  M. P. Decomposes
  Density 2.17
Toxicity: Details unknown. See also Palladium Compounds.

AMMONIUM CHLOROPLATINATE

Description: Cubic, yellow crystals.
Formula: $(NH_4)_2PtCl_6$
Constants:
  Mol. Wt. 444.05
  M. P. Decomposes
  Density 3.065
Toxicity: See Platinum Compounds.

AMMONIUM CHLOROPLATINITE

Description: Red crystals.
Formula: $(NH_4)_2PtCl_4$
Constants:
  Mol. Wt. 373.1
  M. P. Decomposes
  Density 2.936
Toxicity: See Platinum Compounds.

AMMONIUM CHLOROPLUMBATE
Description: Yellow crystals.
Formula: $(NH_4)_2PbCl_6$
Constants:
Mol. Wt. 456
M. P. 120°C (decomp.)
Density 2.925
Toxicity: See Lead Compounds.
Disaster Control: See Lead Compounds.
Storage and Handling: Section 7

AMMONIUM CHLOROSTANNATE
Description: White crystals.
Formula: $(NH_4)_2SnCl_6$
Constants:
Mol. Wt. 367.5
M. P. Decomposes
Density 2.4
Toxicity: Details unknown. See also Tin Compounds.

AMMONIUM CHROMATE
Description: Yellow, crystalline material.
Formula: $(NH_4)_2CrO_4$
Constants:
Mol. Wt. 152.1
M. P. Decomposes
Density 1.866
Toxicity: See Chromium Compounds.
Fire Hazard: See Chromates.
Explosion Hazard: Slight, when shocked or heated (Section 7).
Disaster Control: Moderately dangerous; shock or heat will explode it; can react with reducing material.
Storage and Handling: Section 7

AMMONIUM CHROMIC SULFATE
Description: Green or violet crystals.
Formula: $NH_4Cr(SO_4)_2 \cdot 12H_2O$
Constants: Mol. Wt. 478.4
M. P. 94°C ($-9H_2O$ @100°C)
Density 1.720
Toxicity: See Chromium Compounds.
Disaster Control: See Sulfates.
Storage and Handling: Section 7

AMMONIUM COBALTOUS o-PHOSPHATE
Description: Violet crystals or powder.
Formula: $NH_4CoPO_4 \cdot H_2O$
Constant: Mol. Wt. 190
Toxicity: See Cobalt Compounds.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3

AMMONIUM COBALTOUS SULFATE
Description: Red crystals.
Formula: $(NH_4)_2SO_4 \cdot CoSO_4 \cdot 6H_2O$
Constants:
Mol. Wt. 395.3
Density 1.902
Toxicity: See Cobalt Compounds.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3

AMMONIUM COPPER ARSENITE
Toxicity: See Arsenic Compounds.
Disaster Control: Dangerous; when heated to decomposition, or on contact with acid or acid fumes, it emits highly toxic fumes of arsenic.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

AMMONIUM CUPRIC CHLORIDE
Description: Blue crystals.
Formula: $2NH_4Cl \cdot CuCl_2 \cdot 2H_2O$
Constants: Mol. Wt. 277.5
M. P. Decomposes @110°C
Density 1.993
Toxicity: See Copper Compounds.

AMMONIUM CUPRIC SULFATE
Description: Blue, violet crystals.
Formula: $(NH_4)_2SO_4 \cdot CuSO_4$
Constant: Mol. Wt. 291.8
Toxicity: See Copper Compounds.

AMMONIUM CUPROUS IODIDE
Description: Crystals.
Formula: $NH_4I \cdot CuI \cdot H_2O$
Constant: Mol. Wt. 353.4
Toxicity: See Copper Compounds and Iodides.

AMMONIUM CYANATE
Description: White crystals.
Formula: NH_4OCN
Constants:
Mol. Wt. 60.1
M. P. Decomposes @60°C
Toxicity: Details unknown. See also Cyanates.
Disaster Control: Dangerous; when

heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides.
Storage and Handling: Section 7

AMMONIUM CYANIDE
Description: Solid, white powder or crystal.
Formula: NH_4CN
Constants:
Mol. Wt. 44.1
M. P. 36°C
B. P. 31.7°C (sublimes)
Density 1.002 g/liter @100°C
Vap. Press. 400 mm @20.5°C
Toxicity: See Cyanides.
Fire Hazard: Moderate, when exposed to heat or flame. At 95° a flammable gas is evolved (Section 6).
Explosion Hazard: Moderate, when heated. At 95°F a gas is liberated. See also Hydrogen Cyanide.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

AMMONIUM CYANOAURATE
Description: Colorless plates.
Formula: $NH_4Au(CN)_4 \cdot H_2O$
Constants:
Mol. Wt. 337.3
M. P. Decomp. @200°C
Toxicity: See Cyanides and Gold Compounds.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

AMMONIUM CYANOAURITE
Description: Colorless crystals.
Formula: $NH_4Au(CN)_2$
Constants:
Mol. Wt. 267.3
M. P. Decomp. @100°C
Toxicity: See Cyanides and Gold Compounds.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

AMMONIUM CYANOPLATINITE
Description: Yellow crystals.
Formula: $(NH_4)_2Pt(CN)_4 \cdot H_2O$
Constant:
Mol. Wt. 353.4
Toxicity: See Cyanides and Platinum Compounds.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

AMMONIUM DECABORATE. See Ammonium Pentaborate.

AMMONIUM DICHROMATE. See Ammonium Bichromate.

AMMONIUM DICYANOGUANIDINE
Description: Crystals.
Formula: $NH_4[NH_2CN(NCN)CN]$
Constants:
Mol. Wt. 126.2
M. P. > 300°C
Toxicity: Highly toxic. See also Cyanides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides.
Storage and Handling: Section 7

AMMONIUM DIFLUOPHOSPHATE
Description: Colorless crystals.
Formula: $NH_4PO_2F_2$
Constants:
Mol. Wt. 119
M. P. 213°C
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

AMMONIUM DIHYDROGEN ARSENATE
Description: Colorless crystals.
Formula: $NH_4H_2AsO_4$
Constants:
Mol. Wt. 159
M. P. Decomp. to lose NH_3
Density 2.311
Toxicity: See Arsenic Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of arsenic.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

AMMONIUM DINITRO-o-CRESOL
Description: Crystals.
Formula: $C_7H_9O_5N_3$
Constant:
Mol. Wt. 215.2
Toxic Hazard Rating:
Acute Local: Irritant 3;

Ingestion 3
Acute Systemic: U
Chronic Local: Irritant 3
Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Fire Hazard: See Nitrates
Explosion Hazard: See Nitrates
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; can react violently with reducing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1

AMMONIUM EMBELATE

Description: Grayish-violet powder.
Formula: $(NH_4)_2C_{18}H_{26}O_4$
Constant:
Mol. Wt. 342.47
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slightly dangerous; when heated, it emits acrid fumes (Section 6).
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

AMMONIUM FERRICYANIDE

Description: Red crystals.
Formula: $(NH_4)_3Fe(CN)_6$
Constants:
Mol. Wt. 266.1
M. P. Decomposes
Toxicity: See Ferricyanides.
Disaster Control: See Ferricyanides.

AMMONIUM FERROCYANIDE

Description: Yellow to blue cyrstals.
Formula: $(NH_4)_4Fe(CN)_6 \cdot 3H_2O$
Constants:
Mol. Wt. 338.2
M. P. Decomposes
Toxicity: See Ferrocyanides.
Disaster Control: See Ferrocyanides.

AMMONIUM FLUOANTIMONITE

Description: Colorless crystals.
Formula: $(NH_4)_2SbF_6$
Constants:
Mol. Wt. 252.8
M. P. Sublimes with decomp.
Toxicity: See Fluorides and Antimony Compounds.
Disaster Control: See Fluorides and Antimony Compounds.
Storage and Handling: Section 7

AMMONIUM FLUOBORATE

Description: Crystals.
Formula: NH_4BF_4
Constants:
Mol. Wt. 104.9
M. P. Sublimes
Density 1.851
Toxicity: See Fluorides and Boron Compounds.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

AMMONIUM FLUOGALLATE

Description: White crystals.
Formula: $(NH_4)_3GaF_6$
Constants:
Mol. Wt. 237.8
B. P. Decomp. to yield GaF_3
Toxicity: See Fluorides and Gallium Compounds.
Disaster Control. See Fluorides.
Storage and Handling: Section 7

AMMONIUM FLUOGERMANATE

Description: Colorless crystals.
Formula: $(NH_4)_2GeF_6$
Constants:
Mol. Wt. 222.1
Density 2.564 @25°/25°C
Toxicity: See Fluorides and Germanium Compounds.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

AMMONIUM FLUORIDE

Description: White crystals.
Formula: NH_4F
Constants:
Mol. Wt. 37.04
M. P. Sublimes
Density 1.315
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

AMMONIUM FLUOSILICATE

Synonyms: Cryptohalite; ammonium silicofluoride.
Description: Colorless crystals.

Formula: $(NH_4)_2SiF_6$
Constants:
Mol. Wt. 178.1
M. P. Sublimes
Density 2.01
Toxicity: See Fluosilicates and Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

AMMONIUM FLUOSULFONATE

Description: Colorless needles.
Formula: NH_4SO_3F
Constants:
Mol. Wt. 117.1
M. P. 244.7°C
Toxicity: See Fluosulfonates.
Disaster Control: See Fluosulfonates.
Storage and Handling: Section 7

AMMONIUM FLUOTITANATE

Description: Crystals.
Formula: $(NH_4)_2TiF_6$
Constants:
Mol. Wt. 198
M. P. Decomposes
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

AMMONIUM FLUOZIRCONATE

Description: Crystals.
Formula: $(NH_4)_2ZrF_6$
Constants:
Mol. Wt. 241.3
Density 1.154
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

AMMONIUM FORMATE

Description: White, deliquescent crystals.
Formula: NH_4COOH
Constants:
Mol. Wt. 63.1
M. P. 116°C
B. P. Decomp. @ 180°C
Density 1.266
Toxicity: Details unknown. See also Esters and Formic Acid.
Fire Hazard: Slightly dangerous; when heated, it emits smoke (Section 6).
Storage and Handling: Section 7

AMMONIUM HEXAFLUOPHOSPHATE

Description: Colorless crystals.
Formula: NH_4PF_6
Constants:
Mol. Wt. 163
M. P. Decomposes
Density 2.180
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

AMMONIUM HEXAFLUOPHOSPHATE FLUORIDE

Description: White crystals or powder.
Formula: $NH_4PF_6NH_4F$
Constants:
Mol. Wt. 200.06
M. P. No melting, sublimes at about 140°C
Toxicity: See Fluorides and Ammonium Hexafluophosphate.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

AMMONIUM HYDROGEN FLUORIDE

See Ammonium Bifluoride.

AMMONIUM HYDROGEN SELENATE

Description: Crystals.
Formula: NH_4HSeO_4
Constants:
Mol. Wt. 162.0
M. P. Decomposes
Density 2.162
Toxicity: See Selenium Compounds.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

AMMONIUM HYDROXIDE

Synonyms: Aqua ammonium; water of ammonia; aqua ammonia; ammonium hydrate.
Description: Colorless liquid.
Formula: NH_4OH
Constants:
Mol. Wt. 35.05
M. P. −77°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 3; Inhalation 2
Acute Systemic: U
Chronic Local: Irritant 2
Chronic Systemic: U
MAC: ACGIH (accepted); 100 parts per million in air.
Fire Hazard: Slight; when heated, it emits toxic fumes; can react with oxidizing materials (Section 6).
Disaster Control: Dangerous; emits irritating fumes and liquid can

inflict burns. Use with adequate ventilation.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
MCA warning label.

AMMONIUM IODIDE

Description: Colorless, hygroscopic crystals.
Formula: NH_4I
Constants:
- Mol. Wt. 145
- M. P. Sublimes @ 551 °C
- B. P. 404.9 °C
- Density 2.514
- Vap. Press. 1 mm @ 210.9 °C (sublimes)

Toxicity: See Iodides.
Disaster Control: See Iodides.
Storage and Handling: Section 7

AMMONIUM MAGNESIUM ARSENATE

Description: Colorless crystals.
Formula: $NH_4MgAsO_4 \cdot 6H_2O$
Constants:
- Mol. Wt. 289.4
- M. P. Decomposes
- Density 1.932 @ 15 °C

Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

AMMONIUM MAGNESIUM CHROMATE

Description: Yellow crystals.
Formula: $(NH_4)_2CrO_4 \cdot MgCrO_4 \cdot 6H_2O$
Constants:
- Mol. Wt. 400.5
- M. P. Decomposes
- Density 1.84

Toxicity: See Chromium Compounds.
Fire Hazard: Moderate, as a result of chemical reaction with reducing agents (Section 6).
Caution: An oxidizer.
Disaster Control: Moderately dangerous; when heated, it can explode.
Storage and Handling: Section 7

AMMONIUM MOLYBDATE

Description: Colorless crystals.
Formula: $(NH_4)_2MoO_4$
Constants:
- Mol. Wt. 196
- M. P. Decomposes
- Density 2.27

Toxicity: Details unknown. See also Molybdenum Compounds.

AMMONIUM MOLYBDOTELLURATE

Description: Colorless crystals.
Formula: $(NH_4)_6(TeMo_6O_{24}) \cdot 7H_2O$
Constants:
- Mol. Wt. 1321.7
- M. P. 550 °C (decomp.)
- B. P. Decomposes
- Density 2.78

Toxicity: See Tellurium Compounds.
Disaster Control: See Tellurium Compounds.
Storage and Handling: Section 7

AMMONIUM MONOHYDROGEN ARSENATE (SOLID)

Description: White crystals or powder.
Formula: $(NH_4)_2HAsO_4$
Constants:
- Mol. Wt. 176
- M. P. Decomposes
- Density 1.989

Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

AMMONIUM NICKEL CHLORIDE

Description: Green crystals.
Formula: $NH_4Cl \cdot NiCl_2 \cdot 6H_2O$
Constants:
- Mol. Wt. 291.2
- Density 1.645

Toxicity: See Nickel Compounds

AMMONIUM NICKEL SULFATE

Synonym: Double nickel salt.
Description: Black to green crystals.
Formula: $(NH_4)_2SO_4 \cdot NiSO_4 \cdot 6H_2O$
Constants:
- Mol. Wt. 395
- Density 1.923

Toxicity: See Nickel Compounds.

AMMONIUM NITRATE

Description: Colorless crystals.
Formula: NH_4NO_3
Constants:
- Mol. Wt. 80.05
- M. P. 169.6 °C

B. P. Decomp. @ 210 °C
Density 1.725 @ 25 °C
Toxicity: See Nitrates.
Fire Hazard: See Nitrates.
To Fight Fire: Use water in large amounts. It is important that the mass of material be kept cool and that burning be extinguished promptly. Ventilate well (Section 6).
Explosion Hazard: May explode under confinement and high temperatures. Explosions have occurred in ships holds, etc. There have been warehouse fires that did not detonate (Section 7). See also Nitrates.
Caution: This material explodes more readily if contaminated, must be kept cool and unconfined. See also Explosives, High.
Disaster Control: Dangerous; heat and confinement may explode it; when heated to decomposition it emits highly toxic fumes of oxides of nitrogen; can react vigorously with reducing materials.
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

AMMONIUM NITRATE, FERTILIZER. See Ammonium Nitrate.
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.

AMMONIUM NITRITE
Description: White to yellow crystals.
Formula: NH_4NO_2
Constants:
Mol. Wt. 64.1
M. P. Decomposes
Flash P. 158 °F
Vap. D. 1.69
Toxicity: See Nitrites.
Fire Hazard: See Nitrites.
Explosion Hazard: Severe, when shocked or exposed to heat (Section 7).
Disaster Control: See Nitrites.
Storage and Handling: Section 7

AMMONIUM OXALATE
Description: Colorless crystals.
Formula: $(NH_4)_2C_2O_4 \cdot H_2O$
Constants:
Mol. Wt. 142.12
M. P. Decomposes
Density 1.50
Toxicity: See Oxalates.

AMMONIUM PENTABORATE
Synonym: Ammonium decaborate.
Description: White solid.
Formula: $NH_4B_5O_8 \cdot 4H_2O$
Constant:
Mol. Wt. 272.20
Toxicity: See Boron Compounds.

AMMONIUM PERCHLORATE
Description: White crystals.
Formula: NH_4ClO_4
Constants:
Mol. Wt. 117.50
M. P. Decomposes
Density 1.95
Toxicity: See Perchlorates.
Fire Hazard: Moderate; when exposed to heat or flame or by spontaneous chemical reaction with reducing materials (Section 6).
Caution: A very powerful oxidizer. Ignites violently with combustibles, etc.
Explosion Hazard: Severe, when shocked, exposed to heat or by spontaneous chemical reaction. Explodes at high temperatures. When contaminated by reducing materials it can become a very sensitive high explosive (Section 7). See also Perchlorates.
Disaster Control: See Perchlorates and Explosives, High.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

AMMONIUM PERCHROMATE. See Ammonium Peroxychromate.

AMMONIUM m-PERIODATE
Description: Colorless crystals.
Formula: NH_4IO_4
Constants:
Mol. Wt. 209
M. P. Explodes
Density 3.056

Toxicity: See Periodates.
Fire Hazard: See Periodates.
Explosion Hazard: See Periodates.
Disaster Control: See Periodates.
Storage and Handling: Section 7

AMMONIUM PERMANGANATE

Description: Crystalline solid.
Formula: NH_4MnO_4
Constants:
  Mol. Wt. 137.0
  M. P. Explodes
  Density 2.208
Toxicity: See Manganese Compounds.
Fire Hazard: Moderate, by chemical reaction with reducing agents (Section 6).
Caution: A powerful oxidizer.
Explosion Hazard: Moderate, when shocked or exposed to heat. Can be exploded by percussion (Section 7).
Disaster Control: Moderately dangerous, shock and heat will explode it; when heated to decomposition, it emits toxic fumes; can react with reducing material.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C Classification: Oxidizing material; yellow label.
  Coast Guard Classification: Oxidizing material; yellow label.

AMMONIUM PEROXYBORATE

Description: White crystals.
Formula: $NH_4BO_3 \cdot \frac{1}{2}H_2O$
Constants:
  Mol. Wt. 85.9
  M. P. Decomposes
Toxicity: See Boron Compounds.
Fire Hazard: Slight, by chemical reaction with reducing agents (Section 6).
Caution: An oxidizer.
Storage and Handling: Section 7

AMMONIUM PEROXYCHROMATE

Description: Red-brown crystals.
Formula: $(NH_4)_3CrO_8$
Constants:
  Mol. Wt. 234.1
  M. P. Decomp. @ 40 °C
  B. P. Expl. @ 50 °C
Toxicity: See Chromium Compounds.
Fire Hazard: Moderate, by chemical reaction with reducing agents (Section 6).
Caution: A powerful oxidizer.
Explosion Hazard: Moderate, when heated (Section 7).
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes and may explode.
Storage and Handling: Section 7

AMMONIUM PERRHENATE

Description: White plates.
Formula: NH_4ReO_4
Constants:
  Mol. Wt. 268.4
  M. P. Decomposes
  B. P. Decomposes.
Toxicity: Details unknown. See also Rhenium Compounds.
Fire Hazard: Moderate, by chemical reaction with reducing agents (Section 6).

AMMONIUM PERSULFATE

Synonym: Ammonium peroxydisulfate.
Description: White crystals.
Formula: $(NH_4)_2S_2O_8$
Constants:
  Mol. Wt. 228.20
  M. P. Decomposes 120 °C
  Density 1.982
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1; Inhalation 1
  Acute Systemic: U
  Chronic Local: Irritant 1
  Chronic Systemic: U
Fire Hazard: Moderate, by chemical reaction with reducing agents (Section 6).
Caution: A powerful oxidizer.
Explosion Hazard: Moderate, when shocked, exposed to heat, or by spontaneous chemical reaction. Generally requires contact with reducing materials or combustibles.
Disaster Control: Dangerous; will explode when shocked or heated; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react vigorously with reducing material.
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

AMMONIUM PICRATE

Synonyms: Ammonium carbazotate;

ammonium picronitrate.
Description: Yellow crystals.
Formula: $NH_4C_6H_2N_3O_7$
Constants:
Mol. Wt. 246.14
M. P. Decomposes
B. P. Explodes @423°C
Density 1.719
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 2; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Allergen 2
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Fire Hazard: Moderate, by spontaneous chemical reaction (Section 6).
Caution: A powerful oxidizer.
Explosion Hazard: Severe when shocked or exposed to heat or flame (Section 7). See also Explosives, High.
Disaster Control: Highly dangerous; will explode when shocked; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen, etc.; can react vigorously with reducing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: High explosive.
Coast Guard Classification: High explosive.

AMMONIUM PICRATE, WET

Synonym: Ammonium carbazotate.
Toxicity: See Ammonium Picrate.
Fire Hazard: Moderate, by chemical reaction with reducing agents (Section 6).
Caution: An oxidizer.
Explosion Hazard: Moderate, when heated (Section 7).
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of oxides of nitrogen, etc., and explodes.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: (Not to exceed 16 oz.) See Section 11, §73.192.
Coast Guard Classification: (Not less than 10% water, not to exceed 16 oz.) Inflammable Solid.

AMMONIUM POLYSULFIDE. See Ammonium Sulfide.

AMMONIUM SELENATE

Description: Colorless crystals.
Formula: $(NH_4)_2SeO_4$
Constants: Mol. Wt. 179.04
M. P. Decomposes
Density 2.194
Toxicity: See Selenium Compounds.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

AMMONIUM SELENIDE

Description: Brown crystals.
Formula: $(NH_4)_2Se$
Constants: Mol. Wt. 115.0
B. P. Decomposes
Toxicity: See Selenium Compounds.
Fire Hazard: See Hydrogen Selenide.
Disaster Control: Dangerous; when heated to decomposition, or on contact with acid or acid fumes, it emits highly toxic fumes of selenium and it will react with water or steam to produce toxic and flammable vapors.
Storage and Handling: Section 7

AMMONIUM SELENITE

Description: Colorless or slightly reddish crystals.
Formula: $(NH_4)_2SeO_3 \cdot H_2O$
Constant: Mol. Wt. 167.05
Toxicity: See Selenium Compounds.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

AMMONIUM SILICOFLUORIDE

See Ammonium Fluosilicate.

AMMONIUM SULFAMATE

Synonym: Ammate.
Description: Deliquescent crystalline material (white crystalline solid).
Formula: $NH_4OSO_2NH_2$
Constants: Mol. Wt. 114.1
B. P. 160°C (decomp.)
M. P. 125°C
Toxicity: Details unknown; an

herbicide.
MAC: ACGIH (tentative); 15 milligrams per cubic meter of air.
Explosion Hazard: Slight, when exposed to heat or by spontaneous chemical reaction (hydrolysis); in a hot acid solution this material can undergo spontaneous hydrolysis liberating much heat.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

AMMONIUM SULFATE
Description: Brownish-gray to white crystals.
Formula: $(NH_4)_2SO_4$
Constants: Mol. Wt. 132.09
  M. P. Decomposes
  Density 1.77
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1; Inhalation 1
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Personal Hygiene: Section 3

AMMONIUM SULFHYDRATE
Synonyms: Ammonium hydrosulfide; ammonium hydrogen sulfide.
Description: Powder or crystals.
Formula: NH_4HS
Constants: Mol. Wt. 51.11
  M. P. 118°C (decomp.)
  B. P. 120°C (sublimes)
  Vap. Press. 400 mm @21.8°C
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Disaster Control: See Sulfides.
Explosion Hazard: See Sulfides.
Storage and Handling: Section 7

AMMONIUM SULFIDE
Synonym: Ammonium monosulfide.
Description: Yellow, hygroscopic crystals.
Formula: $(NH_4)_2S$
Constants: Mol. Wt. 68.2
  M. P. Decomposes
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

AMMONIUM SULFITE
Description: Colorless crystals.
Formula: $(NH_4)_2SO_3 \cdot H_2O$
Constants: Mol. Wt. 134.16
  M. P. Decomposes
  B. P. Sublimes @150°C
  Density 1.41 @25°C
Toxicity: See Sulfites.
Disaster Control: See Sulfites.
Storage and Handling: Section 7

AMMONIUM TELLURATE
Description: White powder.
Forumla: $(NH_4)_2TeO_4$
Constants: Mol. Wt. 227.7
  M. P. Decomposes
  Density 3.01 @25°C
Toxicity: See Tellurium Compounds.
Disaster Control: See Tellurium Compounds.
Storage and Handling: Section 7

AMMONIUM TETRABORATE. See Ammonium Biborate.

AMMONIUM THALLIUM CHLORIDE
Description: Colorless crystals.
Formula: $3NH_4Cl \cdot TlCl_3 \cdot 2H_2O$
Constants:
  Mol. Wt. 507.3
  Density 2.39
Toxicity: See Thallium Compounds.
Disaster Control: See Thallium Compounds.
Storage and Handling: Section 7

AMMONIUM THIOANTIMONATE
Description: Yellow crystals.
Formula: $(NH_4)_3SbS_4 \cdot 4H_2O$
Constants:
  Mol. Wt. 376.2
  M. P. Decomposes
Toxicity: See Antimony Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur and antimony.
Storage and Handling: Section 7

AMMONIUM THIOCYANATE
Synonym: Ammonium sulfocyanate.
Description: Colorless solid.
Formula: NH_4SCN
Constants:
  Mol. Wt. 76.1
  M. P. 149.6°C
  B. P. Decomposes @170°C
  Density 1.305

Toxicity: See Thiocyanates.
Disaster Control: See Thiocyanates.
Storage and Handling: Section 7

AMMONIUM THIOGLYCOLATE

Description: Colorless liquid, strong skunk-like odor.
Formula: $HSCH_2COONH_4$
Constant:
MOl. Wt. 109.1
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Allergen 2
Chronic Systemic: Inhalation 3
Caution: Emits hydrogen sulfide. Upon local contact it can cause a contact dermatitis (Section 9).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of sulfides.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

AMMONIUM THIOSULFATE

Description: White, monoclinic crystals.
Formula: $(NH_4)_2S_2O_3$
Constant:
Mol. Wt. 148.2
Toxicity: See Thiosulfates.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

AMMONIUM TRICHLOROACETATE

Description: Colorless crystals.
Formula: $NH_4O_2CCCl_3$
Constants:
Mol. Wt. 180.6
Toxic Hazard Rating:
Acute Local; Irritant 2; Ingestion 3; Inhalation 2
Acute Systemic: U
Chronic Local: Irritant 1
Chronic Systemic: Ingestion 1; Inhalation 1
Disaster Control: Moderately dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits toxic fumes; will react with water or steam to produce toxic or corrosive fumes.
Ventilation Contol (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

AMMONIUM TRIIODIDE

Description: Brown crystals.
Formula: NH_4I_3
Constants:
Mol. Wt. 398.8
Density 3.749
Toxicity: See Iodides.
Disaster Control: See Iodides.
Storage and Handling: Section 7

AMMONIUM URANYL CARBONATE

Description: Yellow crystals.
Formula: $2(NH_4)_2CO_3 \cdot UO_2CO_3 \cdot 2H_2O$
Constants:
Mol. Wt. 558.3
M. P. Decomposes @100°C
Density 2.773
Toxicity: See Uranium Compounds, Soluble.
Radiation Hazard: See Uranium.

AMMONIUM URANYL PENTAFLUORIDE

Description: Crystals.
Formula: $(NH_4)_3UO_2F_5$
Constants:
Mol. Wt. 419.2
M. P. Sublimes
Density 3.186
Toxicity: See Uranium Compounds, Soluble and Fluorides.
Radiation Hazard: See Uranium.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of fluorides.
Storage and Handling: Section 7

AMMONIUM m-VANADATE

Description: Colorless to yellow crystals.
Formula: NH_4VO_3
Constants:
Mol. Wt. 117
M. P. Decomposes
Density 2.326
Toxicity: See Vanadium Compounds.

AMMONIUM ZINC SULFATE

Description: White crystals.
Formula: $(NH_4)_2SO_4 \cdot ZnSO_4 \cdot 6H_2O$
Constants:
  Mol. Wt. 401.7
  M. P. Decomposes
  Density 1.931
Toxicity: See Zinc Compounds.

AMOBARBITAL

Synonyms: 5-Ethyl-5-isoamylbarbituric acid; amytal.
Description: Slightly bitter crystals.
Formula: $C_{11}H_{18}N_2O_3$
Constant:
  Mol. Wt. 226.27
Toxic Hazard Rating:
  Acute Local: Allergen 1; Ingestion 2
  Acute Systemic: Ingestion 2
  Chronic Local: Allergen 1
  Chronic Systemic: Ingestion 1; Inhalation 1
Caution: Continued use of this material may lead to habituation.
Fire Hazard: Slight; on decomposition it emits toxic fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

"AMSCO" NAPHTHAS and SOLVENTS

Description: Liquid petroleum hydrocarbons.
Composition: 40 - 90% aromatic hydrocarbons.
Toxicity: Variable. See specific petroleum hydrocarbon.
Fire Hazard: Variable.
Explosion Hazard: Variable.

AMYL ACETATE

Synonyms: Amyl acetic ether; pear oil.
Description: Colorless liquid, pear or banana-like odor.
Formula: $CH_3COO(CH_2)_4CH_3$
Constants:
  Mol. Wt. 130.18
  M. P. −78.5°C
  B. P. 148°C (737mm)
  Flash P. 77°F (C.C.)
  Density 0.879 @ 20°/20°C
  Autoign. Temp. 750°F
  Vap. D. 4.5
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 2; Inhalation 2
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: Irritant 1
  Chronic Systemic: U
MAC: ACGIH (accepted); 200 parts per million in air; 1064 milligrams per cubic meter of air.
Toxicology: Chronic toxicity is of a very low order. When inhaled in high concentrations, amyl acetate is irritating to the mucous membranes; it also possesses a narcotic effect, and from animal experiments it appears to be more toxic than butyl acetate. A concentration of 1,000 ppm, breathed for half an hour, has cause headache, fatigue, oppression in the chest, and irritation of the eyes and mucous membranes of the nose and throat, with excessive salivation. 5,000 ppm produces deep narcosis in cats in 30 minutes.

Symptoms are burning of the eyes, lacrimation, headache, irritation and dryness of the throat, "dopiness", fatigue, and occasionally vague nervousness. See also Esters, Amyl Alcohol, Acetic Acid.
Fire Hazard: Dangerous, when exposed to heat or flame; when heated, it emits acrid fumes; can react with oxidizing materials.
Underwriters Laboratory Classification: 55-60
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame (Section 7).
Explosive Range: 1.10% (L.E.L.)
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Inflammable liquid; red label.

sec-AMYL ACETATE

Synonym: Amyl acetate.
Description: Colorless liquid.
Formula: $CH_3CO_2C_5H_{11}$

Constants:
- Mol. Wt. 130.1
- B. P. 249°F
- Flash P. 89°F (C.C.)
- Density 0.862-0.866 @20°/20°C
- Vap. D. 4.48

Toxicity: Probably toxic. See also Esters, Amyl Alcohol, Acetic Acid, Amyl Acetate.

Fire Hazard: Dangerous, when exposed to heat or flame; when heated, it emits acrid fumes, can react with oxidizing materials.

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Unknown

Storage and Handling: Section 7

AMYL ALCOHOL

Synonyms: 1-Pentanol; primary amyl alcohol.

Description: Clear liquid.

Formula: $CH_3CH_2CH_2CH_2CH_2OH$

Constants:
- Mol. Wt. 88.1
- M. P. -79°C
- B. P. 137.8°C
- Flash P. 100°F (C.C.)
- Density 0.8168 @20°/20°C
- Autoign. Temp. 700°F
- Vap. Press. 1 mm @13.6°C, 10 mm @44.9°C
- Vap. D. 3.04

Toxic Hazard Rating:
- Acute Local: Irritant 1
- Acute Systemic: Ingestion 3; Inhalation 3
- Chronic Local: U
- Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2

Toxicology: According to animal experiments, the amyl alcohols are about four times as toxic as ethyl alcohol. However, because of their low volatility and their low solubility in the body fluids, they are absorbed slowly and only to a small extent. There is little definite evidence that their use in industry has resulted in poisoning. The vapor may, however, be irritant to the eyes and the upper respiratory tract. See also Alcohols.

Fire Hazard: Moderate, when exposed to heat or flame; when heated, it emits acrid fumes, can react with oxidizing materials.

Underwriters Laboratory Classification: 40

Spontaneous Heating: No

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Moderate, when exposed to flame (Section 7).

Explosive Range: 1.2%(L.E.L.)

Ventilation Control (use normal rate): Section 2

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

Shipping Regulations: Section 11.
Coast Guard Classification: Combustible liquid.

sec-n-AMYL ALCOHOL

Synonym: Methyl propyl carbinol, 3-pentanol, diethyl carbinol.

Description: Colorless liquid.

Formula: $CH_3CH_2CH_2CHOHCH_3$

Constants:
- Mol. Wt. 88.2
- B. P. 116°C
- Flash P. 94°F (C.C.)
- Freezing P. -50°C
- Density 0.8169 @20°/20°C
- Autoign. Temp. 650°F to 725°F
- Vap. D. 3.04

Toxic Hazard Rating:
- Acute Local: Irritant 1; Ingestion 3; Inhalation 3
- Acute Systemic: Ingestion 3; Inhalation 3
- Chronic Local: U
- Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2

Fire Hazard: Moderate, when exposed to heat or flame; when heated, it emits acrid fumes; can react with oxidizing materials.

Underwriters Laboratory Classification: 40-45

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Unknown

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

AMYL ALCOHOL, COMMERCIAL

See Isoamyl Alcohol.

tert-AMYL ALCOHOL, REFINED

Synonyms: Dimethyl ethyl carbinol; 2-methyl-2-butanol.
Description: Colorless liquid.
Formula: $CH_3CH_2C(CH_3)OHCH_3$
Constants:
Mol. Wt. 88.15
M. P. -11.9°C
B. P. 101.8°C
Flash P. 67°F (C.C.)
Density 0.809
Autoign. Temp. 819°F
Vap. Press. 10 mm @17.2°C
Vap. D. 3.03
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Fire Hazard: Dangerous, when exposed to heat or flame. When heated, it emits acrid fumes; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

AMYL ALCOHOL, SYNTHETIC

Synonym: Pentasol
Description: Water-white liquid.
Formula: $C_5H_{11}OH$
Constants:
Mol. Wt. 88.15
B. P. 118 - 140°C
Flash P. 115°F
Density 0.81-0.82 @20°/20°C
Toxicity: See n-Amyl Alcohol.
Fire Hazard: Moderate, when exposed to heat or flame; when heated it emits acrid fumes, can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

AMYLAMINE

Synonyms: 1-Amino pentane.
Description: Water-white liquid.
Formula: $CH_3(CH_2)_4NH_2$
Constants:
Mol. Wt. 87.16
M. P. -55°C
B. P. 104°C
Flash P. 30°F (O.C.)
Density 0.7614 @20°/4°C
Vap. D. 3.01
Toxicity: Unknown.
Fire Hazard: Dangerous, when exposed to heat or flame; when heated, it emits smoke; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

AMYLAMINE LAURATE

Description: Liquid.
Constants:
Flash P. 150°F
Density 0.88
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; when heated, it emits smoke; can react with oxidizing materials.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

AMYLAMINE OLEATE

Description: Liquid.
Constants:
Flash P. 220°F
Density 0.89
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; when heated, it emits smoke; can react with oxidizing materials.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

AMYLAMINE STEARATE

Description: Liquid.
Constants:
Flash P. 160°F
Density 0.88
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; when heated, it emits smoke; can react with oxidizing materials.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon

tetrachloride (Section 6).
Storage and Handling: Section 7

AMYL BENZENE
Description: Liquid.
Formula: $C_6H_5C_5H_{11}$
Constants:
Mol. Wt. 148.24
B. P. 365°F
Flash P. 150°F (O.C.)
Density 0.78 - 0.85
Vap. D. 5.11
Toxicity: See Benzene.
Fire Hazard: Moderate, when exposed to heat or flame; when heated it emits acrid fumes; reacts with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

AMYL BENZOATE
Description: Clear liquid.
Formula: $C_6H_5COOC_5H_{11}$
Constants:
Mol. Wt. 192.3
B. P. 420 - 509°F
Flash P. 230°F
Density 0.98
Toxicity: Details unknown. See also Esters, Amyl Alcohol, Benzoic Acid.
Fire Hazard: Moderate, when exposed to heat or flame; when heated, it emits acrid fumes; reacts with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

N-AMYL BENZYLCYCLOHEXYLAMINE
Description: Liquid.
Formula: $C_{17}H_{27}N$
Constant:
Mol. Wt. 245.4
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: A moderately flammable liquid; when heated, it emits toxic fumes; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

AMYL BENZYL ETHER
Synonyms: Benzyl isoamyl ether; "gardenia oxide."
Description: Liquid
Formula: $C_5H_{11}OCH_2C_6H_5$
Constants:
Mol. Wt. 178.3
B. P. 235°C
Density 0.965 @15.5°/15.5°C
Toxicity: Details unknown. See also Ethers.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical, or carbon tetrachloride (Section 6).
Explosion Hazard: See Ethers.
Storage and Handling: Section 7

AMYLBIPHENYL
Description: Liquid.
Formula: $C_5H_{11}C_6H_4C_6H_5$
Constants:
Mol. Wt. 224.3
M. P. -60°C
B. P. 305 - 337°C
Flash P. 300°F
Density 0.958 @20°/20°C
Vap. D. 7.73
Toxicity: unknown
Fire Hazard: Slight when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

AMYL BROMIDE
Description: Colorless liquid.
Formula: $CH_3(CH_2)_4Br$
Constants:
Mol. Wt. 151.1
B. P. 128 - 130°C
Flash P. 90°F
Freezing P. < -30°C
Density 1.211 @25°/25°C
Toxicity: See Halogenated Hydrocarbons.
Fire Hazard: Moderate, when

exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; can react with oxidizing material.
Storage and Handling: Section 7

tert-AMYL CARBAMATE

Description: Crystals, camphor odor.
Formula: $CH_3CH_2CH_2CH_2CH_2CO_2NH_2$
Constants:
Mol. Wt. 131.2
M. P. 83 - 86°C
Toxicity: Unknown
Fire Hazard: Slight; when heated, it emits toxic fumes (Section 6).
Storage and Handling: Section 7

AMYL CARBINOL

Synonyms; n-Hexyl Alcohol; hexanol; pentylcarbinol.
Description: Colorless liquid.
Formula: $CH_3(CH_2)_4CH_2OH$
Constants:
Mol. Wt. 102.2
M. P. -52°C
B. P. 155 - 158°C
Flash P. 145°F (C. C.)
Density 0.820 @20°C
Toxicity: Details unknown. See also Alcohols.
Fire Hazard: Moderate; when exposed to heat or flame; when heated, it emits acrid fumes; reacts with oxidizing materials.
Storage and Handling: Section 7

AMYL CHLORIDE

Description: Water-white, sweet odor.
Formula: $CH_3(CH_2)_3CH_2Cl$
Constants:
Mol. Wt. 106.60
M. P. -99°C
B. P. 108.2°C
Flash P. 54°F (O. C.)
Desnity 0.885 @20°/4°C
Autoign. Temp. 498°F
Vap. D. 3.67
Toxicity: Details unknown. See also Chlorinated Paraffins.
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate (Section 7).
Explosive Range: 1.4% (L. E. L.)
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene; can react with oxidizing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

tert-AMYL CHLORIDE

Description: Liquid
Formula: $CH_3CH_2CCl(CH_3)CH_3$
Constants:
Mol. Wt. 106.6
B. P. 187°F
Density 1.407
Autoign. Temp. 649°F
Vap. D. 3.67
Toxicity: Details unknown. See also Chlorinated Paraffins.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene; can react with oxidizing materials.
Storage and Handling: Section 7

AMYL CHLORIDE, MIXED

Description: Straw to deep-purple colored.
Formula: $C_5H_{11}Cl$
Constants:
Mol. Wt. 106.6
B. P. 85 - 109°C
Flash P. 38°F (O. C.)
Density 0.88 @20°C
Vap. D. 3.67
Toxicity: Details unknown. See Chlorinated Paraffins.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon

tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous, when heated to decomposition, it emits highly toxic fumes of phosgene; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

AMYL CHLORONAPHTHALENE

Description: Liquid.
Formula: $C_5H_{11}ClC_{10}H_6$
Constants:
Mol. Wt. 232.8
B. P. 406°F
Flash P. 295°F
Density 1.07
Toxicity: Details unknown. See also Chloronaphthalenes.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene; can react with oxidizing materials.
Storage and Handling: Section 7

p-tert AMYL-o-CRESOL

Formula: $C_5H_{11}C_6H_3OHCH_3$
Constants: Mol. Wt. 178.3
B. P. 496°F
Flash P. 240°F
Density 0.97
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated, it emits highly toxic fumes; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

4-tert-AMYL CYCLOHEXANOL

Description: Liquid.
Formula: $C_5H_{11}C_6H_4OH$
Constants:
Mol. Wt. 164.3
B. P. 469°F
Flash P. 212°F
Density 0.91
Toxicity: Details unknown. See also Cyclohexanol.
Fire Hazard: Moderate, when exposed to heat or flame; when heated, it emits acrid fumes; can react with oxidizing materials (Section 6).
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

AMYL DICHLOROSILANE

Description: Liquid.
Formula: $C_5H_{11}SiHCl_2$
Constants:
Mol. Wt. 171.2
B. P. 235°C
Toxicity: See Chlorosilanes.
Disaster Control: See Chlorosilanes.
Storage and Handling: Section 7

AMYLENE

Synonym: Propylethylene.
Description: Liquid.
Formula: $CH_3(CH_2)_2CHCH_2$
Constants:
Mol. Wt. 70.13
M. P. -124°C
B. P. 36.7°C
Flash P. 0°F (O. C.)
Density 0.666
Autoign. Temp. 523°F
Vap. D. 2.42
Toxic Hazard Rating:
Acute Local: Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame; when heated to decomposition it emits toxic fumes; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame (Section 7).
Explosive Range: 1.6 - 7.7%

Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

AMYLENE HYDRATE. See tert-Amyl Alcohol.

AMYLENES, MIXED
Description: Water-white liquid.
Formula: C_5H_{10}
Constants:
Mol. Wt. 70.58
B. P. 32.2°C
Flash P. Above 0°F
Density 0.66 @20°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame; when heated, it emits acrid fumes; reacts with oxidizing materials (Section 6).
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

AMYL ETHER
Synonyms: Amyl oxide; diamyl ether.
Description: Liquid.
Formula: $(CH_3(CH_2)_3CH_2)_2O$
Constants:
Mol. Wt. 158.3
M. P. −69.3°C
B. P. 338°F
Flash P. 135°F (O.C.)
Density 0.774 @20°/4°C
Vap. D. 5.46
Toxicity: Details unknown. See also Ethers.
Fire Hazard: Moderate, when exposed to heat or flame; when heated, it emits acrid fumes; reacts with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

AMYL FORMATE
Description: Clear liquid.
Formula: $HCOO(CH_2)_4CH_3$
Constants:
Mol. Wt. 116.2
M. P. −73.5°C
B. P. 130.4°C
Flash P. 80°F
Density 0.893 @15°/4°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame; it can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

AMYL LACTATE
Description: Colorless liquid.
Formula: $CH_3CH(OH)COO(CH_2)_4CH_3$
Constants:
Mol. Wt. 160.2
B. P. 210°C
Flash P. 175°F
Density 0.960 @20°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

AMYL LAURATE
Description: Liquid.
Formula: $C_5H_{11}O_2C(CH_2)_{10}CH_3$
Constants:
Mol. Wt. 270.44
B. P. 554°F

Flash P. 300°F
Density 0.86
Toxicity: Unknown.
Caution: May de-fat skin and lead to dermatitis (Section 9).
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

AMYL MERCAPTAN

Synonym: 1-Pentanethiol.
Description: Water-white to yellow liquid.
Formula: $CH_3(CH_2)_4SH$
Constants:
Mol. Wt. 104.21
B. P. 126.64°C
Flash P. 65°F
Density 0.842 @20°C
Vap. Press. 13.8 mm @25°C
Vap. D. 3.59
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Caution: A weak sensitizer. Local contact may cause contact dermatitis (Section 9).
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur; reacts with oxidizing materials.
Ventilation Control (use normal rate): Section 2.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Inflammable liquid; red label.

AMYL METHYL ALCOHOL

Description: Liquid.
Formula: $CH_3(CH_2)_2CH(CH_3)CH_2OH$
Constants:
Mol. Wt. 102.2
B. P. 266°F
Flash P. 114°F (C.C.)
Density 0.804
Vap. D. 3.52
Toxicity: Details unknown. See also Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

AMYL METHYL KETONE

Description: Liquid.
Formula: $CH_3CO(CH_2)_4CH_3$
Constants:
Mol. Wt. 114.2
B. P. 302°F
Flash P. 120°F (O.C.)
Density 0.817
Autoign. Temp. 991°F
Vap. D. 3.94
Toxicity: Details unknown. See also Ketones.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

AMYL NAPHTHALENE

Description: Liquid.
Formula: $C_{10}H_7C_5H_{11}$
Constants:
Mol. Wt. 198.3
M. P. -21°F
B. P. 550°F
Flash P. 225°F (O.C.)
Density 0.973
Vap. D. 6.86
Toxicity: Details unknown. See also Naphthalene.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

AMYL beta-NAPHTHOL

Description: Liquid.
Formula: $C_5H_{11}C_{10}H_7O$
Constants:
Mol. Wt. 214.3
B. P. 586°F
Flash P. 325°F

Density 0.91
Toxicity: Details unknown. See also beta-Naphthol.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

AMYL NITRATE (MIXED ISOMERS)

Description: Liquid.
Formula: $C_5H_{11}NO_3$
Constants:
Mol. Wt. 133.15
B. P. 145°C
Flash P. 118°F
Density 0.99
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame or by spontaneous chemical reaction.
Caution: An oxidizing agent.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Inflammable liquid; red label.

AMYL NITRITE

Synonym: Isoamyl nitrite.
Description: Clear yellowish liquid, peculiar ethereal fruity odor and pungent aromatic taste.
Formula: $CH_3(CH_2)_4NO_2$
Constants:
Mol. Wt. 117.15
B. P. 104°C
Density 0.8528 @ 20°/4°C
Toxic Hazard Rating:
Acute Local: Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: Ingestion 1; Inhalation 1; Skin Absorption 1
Fire Hazard: Moderate, when exposed to heat or flame or by spontaneous chemical reaction (Section 6).
Caution: An oxidizing material.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of nitrogen; can react with oxidizing or reducing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.

AMYL OCTYLAMINE

Description: Liquid.
Formula: $C_5H_{11}NHC_8H_{17}$
Constant:
Mol. Wt. 199.3
Toxicity: Details unknown. An insecticide.
Fire Hazard: A moderately flammable material; when heated, it emits smoke; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

AMYLOFORM

Description: Soft white powder. A formaldehyde-carbohydrate condensation product.
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Caution: Local contact may cause contact dermatitis (Section 9).
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
Personal Hygiene: Section 3
Storage and Handling: Section 7

AMYL OLEATE

Description: Liquid.
Formula: $CH_3(CH_2)_7CH{:}CH(CH_2)_7$-$COOC_5H_{11}$
Constants:
Mol. Wt. 352.6

B. P. 200°C
Flash P. 366°F
Density 0.86
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

AMYL OXIDE. See Amyl Ether.

o-AMYL PHENOL

Description: Liquid.
Formula: $C_5H_{11}C_6H_4OH$
Constants:
Mol. Wt. 164.24
B. P. 342°C
Flash P. 219°F (O.C.)
Density 0.96 - 0.97
Vap. D. 5.66
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3
Acute Systemic: Ingestion 3
Chronic Local: Irritant 2
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, or dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

p-tert-AMYL PHENOL

Synonym: p-(alpha, alpha-Dimethyl propyl) phenol.
Description: Colorless needles.
Formula: $CH_3CH_2C(CH_3)_2C_6H_4OH$
Constants:
Mol. Wt. 164.2
B. P. 250°C
M. P. 92 - 93°C
Toxicity: Details unknown. See also Phenol.
Fire Hazard: A slightly flammable material (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; it can react with oxidizing materials.
Storage and Handling: Section 7

p-tert-AMYL PHENOXYL ETHANOL

Description: Liquid.
Formula: $C_5H_{11}OC_6H_4CH_2CH_2OH$
Constants:
Mol. Wt. 212.3
B. P. 566°F
Flash P. 282°F
Density 1.01
Toxicity: Details unknown. See also Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

p-tert-AMYL PHENOXY ETHYL LAURATE

Description: Liquid.
Formula: $C_5H_{11}OC_6H_4CH_2CH_2OOC-(CH_2)_{10}CH_3$
Constants: Mol. Wt. 390.6
B. P. 464°F
Flash P. 410°F
Density 0.94
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

p-tert-AMYL PHENYL ACETATE

Description: Liquid.
Formula: $C_5H_{11}OC_6H_4CH_3COO$

Constants:
Mol. Wt. 222.3
B. P. 253°C
Flash P. 240°F
Density 0.99
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; it emits toxic fumes on heating (Section 6).
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

p-tert-**AMYL PHENYL-n-AMYL ETHER**

Description: Liquid.
Formula: $C_5H_{11}C_6H_4OHOC_5H_{11}$
Constants:
Mol. Wt. 251.4
B. P. 285°C
Flash P. 260°F
Density 0.9
Toxicity: Details unknown.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical, carbon tetrachloride (Section 6).
Explosion Hazard: Details unknown. See also Ethers.
Storage and Handling: Section 7

AMYL PHENYL ETHER

Description: Liquid.
Formula: $C_5H_{11}OC_6H_5OH$
Constants:
Mol. Wt. 181.3
B. P. 417°F
Flash P. 185°F
Density 0.92
Toxicity: Details unknown. See also Ethers.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7

AMYL PHENYL METHYL ETHER

Description: Liquid
Formula: $C_5H_{11}C_6H_4OHOCH_3$
Constants:
Mol. Wt. 195.3
B. P. 464°F
Flash P. 210°F
Density 0.94
Toxicity: Details unknown. See also Ethers.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7

AMYL PROPIONATE

Synonym: Pentyl propanoate.
Description: Stable, colorless, apple-like odor, liquid.
Formula: $CH_3CH_2COO(CH_2)_4CH_3$
Constants:
Mol. Wt. 144.21
M. P. -73.1°C
B. P. 106.2°C
Flash P. 106°F (O.C.)
Density 0.8761 @15°/4°C
Vap. Press. 10 mm @46.3°C
Vap. D. 5.0
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

AMYL SALICYLATE

Description: Liquid.
Formula: $HOC_6H_4COOC_5H_{11}$
Constants:
Mol. Wt. 208.24
B. P. 266.5°C
Flash P. 270°F (C.C.)
Density 1.065
Vap. D. 7.17
Toxic Hazard Rating:
Acute Local: Irritant 2;

Ingestion 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Caution: Mild sensitizer. Local contact may cause contact dermatitis (Section 9).
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

AMYL SILICATE

Description: Liquid.
Formula: $Si(OC_5H_9)_4$
Constants:
Mol. Wt. 368.6
M. P. 148°C @ 3 mm.
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits toxic fumes (Section 6).
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

AMYL STEARATE

Description: Liquid.
Formula: $CH_3(CH_2)_{16}COOC_5H_{11}$
Constants:
Mol. Wt. 354.60
B. P. 359.5°C
Flash P. 368°F (O.C.)
Density 0.860
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

AMYL SULFIDE

Synonym: Diamyl sulfide.
Description: Liquid
Formula: $(C_5H_{11})_2S$
Constants:
Mol. Wt. 174.3
B. P. 170 - 180°C
Flash P. 185°F (O.C.)
Density 0.85 - 0.91
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

AMYL TOLUENE

Description: Liquid.
Formula: $C_5H_{11}C_6H_4CH_3$
Constants:
Mol. Wt. 162.25
B. P. 400 - 415°F
Flash P. 180°F (O.C.)
Density 0.87
Vap. D. 5.6
Toxicity: Details unknown. See also Toluene.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

AMYL TOLYL ETHER

Description: Liquid.
Formula: $C_5H_{11}OCH_2C_6H_5$
Constants:
Mol. Wt. 178.3
B. P. 440°F
Flash P. 195°F
Density 0.91

Toxicity: Details unknown. See also Ethers.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7

AMYL TRICHLOROSILANE

Description: Liquid.
Formula: $C_5H_{11}SiCl_3$
Constant:
  Mol. Wt. 205.7
Toxicity: See Chlorosilanes.
Disaster Control: See Chlorosilanes.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Corrosive liquid; white label.
  Coast Guard Classification: Corrosive liquid; white label.

AMYL TRIETHOXYSILANE

Description: Liquid.
Formula: $C_5H_{11}Si(OC_2H_5)_3$
Constants:
  Mol. Wt. 234.4
  B. P. 198°C
  Density 0.889 @20°C
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1; Inhalation 1
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: A moderately flammable material; when heated, it emits toxic fumes; reacts with oxidizing materials (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

AMYL XYLYL ETHER

Description: Liquid.
Formula: $C_5H_{11}OC_6H_3(CH_3)_2$
Constants:
  Mol. Wt. 192.29
  B. P. 480 - 500° F
  Flash P. 205°F (O.C.)
  Density 0.907
Toxicity: Details unknown. See also Ethers.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7

ANABASINE

Synonyms: Neonicotine; nicotine isomer.
Description: Colorless, oily liquid.
Formula: $C_{10}H_{14}N_2$
Constants:
  Mol. Wt. 162.2
  B. P. 280.9°C
  Density 1.048 @20°/20°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
  Chronic Local: U
  Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of nitrogen oxides and cyanides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ANABASINE SULFATE

Synonym: Neonicotine sulfate.
Description: Colorless, oily liquid.
Formula: $(C_{10}H_{14}N_2)_2H_2SO_4$
Constant:
  Mol. Wt. 422.5
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
  Chronic Local: U
  Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ANESTHESIN

Synonym: Ethyl-p-aminobenzoate.
Description: Crystals.
Formula: $C_9H_{11}NO_2$

Constants: Mol. Wt. 165.2
M. P. 88 - 90°C
Toxicity: Used medicinally and has low systemic toxicity when taken by mouth. See also Esters, Ethyl Alcohol and p-Amino Benzoic Acid.
Caution: A mild sensitizer. Local contact may cause contact dermatitis (Section 9).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

ANHALONIDINE
Description: White crystals.
Formula: $C_{12}H_{17}NO_3$
Constant:
Mol. Wt. 223.3
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes such as cyanides.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ANILINE
Synonyms: Phenylamine; aminobenzene; aniline oil.
Description: Colorless, oily liquid.
Formula: $C_6H_5NH_2$
Constants:
Mol. Wt. 93.12
B. P. 184.4°C
Flash P. 168°F (C.C.)
Freezing P. −6.2°C
Density 1.02 @20°/4°C
Autoign. Temp. 1000°F
Vap. Press. 1 mm @34.8°C
Vap. D. 3.22
Toxic Hazard Rating:
Acute Local: Allergen 2
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: Allergen 2
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
MAC: ACGIH (accepted); 5 parts per million in air; 19 milligrams per cubic meter of air.
Toxicology: The most important action of aniline on the body is the formation of methemoglobin, with the resulting anoxemia and depression of the central nervous system. Some investigators believe that aniline may also have a direct toxic action, resulting in a fall in blood pressure and cardiac arrhythmia. In acute exposures, which usually result from spilling the liquid on the skin and clothes, but which may also follow the inhalation of the vapor given off when aniline is heated, the signs are of methemoglobinaemia and anoxemia. In less acute exposure which has been prolonged over some weeks or months, there is usually hemolysis of the red blood cells, followed by stimulation of the bone marrow and attempts at regeneration. The red cells may show stippling; immature cells may be present. The white blood cells usually show little change either in number or morphology. The liver may be affected, with production of jaundice. The urine is frequently dark brown or wine colored, and may contain hemoglobin, hematoporphyrin, and in some cases, excretion products of aniline, such as para-aminophenol. Long continued employment in the manufacture of aniline dyes has been associated with the development of papillomatous growths of the bladder, some of which became malignant. Aniline, and certain other amino compounds, particularly benzidine and beta-naphthylamine, have been suspected of causing the condition. See also Naphthylamines.
Caution: Mild sensitizer. Local contact may cause contact dermatitis (Section 9).
Fire Hazard: Moderate, when exposed to heat or flame.
Underwriters Laboratory Classification: 20-25
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits

highly toxic fumes; can react vigorously with oxidizing materials.
Ventilation Control (use high rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

ANILINE ACETATE
Description: Colorless liquid.
Formula: $C_6H_5NH_2CH_3COOH$
Constants:
Mol. Wt. 153.2
Density 1.071
Toxicity: See Aniline.
Disaster Control: See Aniline.
Storage and Handling: Section 7

ANILINE ANTIMONYL TARTRATE
Synonym: Antimonyl aniline tartrate.
Description: White crystals.
Formula: $C_6H_5NH_2H[(SbO)C_4H_4O_6]$
Constant:
Mol. Wt. 380
Toxicity: See Aniline and Antimony Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of aniline and antimony.
Storage and Handling: Section 7

ANILINE BLACK 870
Description: A dye.
Toxicity: An allergen.
Caution: Mild sensitizer. Local contact may cause contact dermatitis (Section 9).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

ANILINE BRILLIANT GREEN
Description: A dye.
Toxicity: An allergen.
Caution: Mild sensitizer. Local contact may cause contact dermatitis (Section 9).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

ANILINE CAMPHORATE
Description: Yellow crystals.
Formula: $(C_6H_5NH_2)_2C_{10}H_{16}O_4$
Constant:
Mol. Wt. 386.5
Toxicity: See Aniline.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of aniline.
Storage and Handling: Section 7

ANILINE DYES
Toxicity: Variable. The finished dyes are generally very much less toxic than many of the intermediates occurring or used in the manufacture of the dyes. Some of the aniline dyes can cause local irritative effects to the eyes, mucous membranes and skin; the basic dyes are believed to be more irritating than the acid dyes. Allergic responses to aniline dyes have been known to occur (Section 9). See also specific compounds.
Disaster Control: Moderately dangerous; when heated to decomposition, they emit toxic fumes.
Storage and Handling: Section 7

ANILINE FLUORIDE
Synonym: Aniline hydrofluoride.
Description: Crystalline powder.
Formula: $C_6H_5NH_2 \cdot HF$
Constant:
Mol. Wt. 113.1
Toxicity: See Aniline and Fluorides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of fluorides and aniline; it will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

ANILINE HYDROBROMIDE
Synonym: Aniline bromide.
Description: White to reddish crystals.
Formula: $C_6H_5NH_2 \cdot HBr$
Constants:
Mol. Wt. 174.0
M. P. 286°C
Toxicity: See Aniline and Bromides.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromides and aniline; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

ANILINE HYDROCHLORIDE

Synonym: Aniline chloride.
Description: Crystals.
Formula: $C_6H_5NH_2 \cdot HCl$
Constants:
Mol. Wt. 129.59
M. P. 198°C
B. P. 245°C
Flash P. 380°F (O.C.)
Density 1.22
Vap. D. 4.46
Toxicity: See Aniline.
Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of aniline and chlorine compounds; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

ANILINE OIL DRUMS, EMPTY

Toxicity: See Aniline
Fire Hazard: Slight, when exposed to heat or flame. Such drums may fill with vapors and under the proper conditions ignite.
Disaster Control: Dangerous, depending on the number involved; when heated, they emit highly toxic fumes of aniline.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Hazardous.

ANILINE SODIUM SULFONATE

Synonyms: Metanilic acid, sodium salt; 3-aminobenzine-1-sulfonic acid.
Description: Tan flakes.
Formula: $C_6H_4(NH_2)(NaSO_3)$
Constant: Mol. Wt. 195
Toxic Hazard: Rating:
Acute Local: Allergen 2
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Allergen 2
Chronic Systemic: Ingestion 3; Inhalation 3
Caution: A mild sensitizer. Local contact may cause contact dermatitis (Section 9). See also Aniline and Sulfonates.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of aniline and oxides of sulfur.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ANILITE

A high explosive mixture composed of liquid NO_2 and carbon disulfide or gasoline. It is extremely sensitive to shock. See Section 7.

ANISE SEED OIL

Description: Colorless or pale yellow liquid.
Composition: 80 - 90% Anethol, methyl chaoicol, anisaldehyde.
Constant:
Density 0.978 - 0.988 @25°/25°C
Caution: A weak sensitizer. Local contact may cause contact dermatitis (Section 9).
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

ANISIC ACID

Description: Light tan powder.
Formula: $CH_3OC_6H_4COOH$
Constants:
Mol. Wt. 152.14
M. P. 180 - 183°C
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

o-ANISIDINE

Synonym: o-Methoxyaniline.
Description: Liquid.
Formula: $CH_3OC_6H_4NH_2$
Constants:
Mol. Wt. 123.15
M. P. 5.2°C

B. P. 225°C
Density 1.108 @26°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 1; Ingestion 2
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: Irritant 2; Allergen 1
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Caution: Local contact may cause a contact dermatitis (Section 9). See also Aniline.
Fire Hazard: Unknown.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes (Section 6).
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1

p-ANISIDINE

Synonym: p-Methoxyaniline.
Description: Liquid.
Formula: $CH_3OC_6H_4NH_2$
Constants:
Mol. Wt. 123.15
M. P. 59°C
B. P. 240°C
Density 1.071 @55°/4°C
Vap. D. 4.28
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 1; Ingestion 2
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: Irritant 2; Allergen 1
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Caution: Mild sensitizer. Local contact may cause a contact dermatitis (Section 9). See also Aniline.
Fire Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it evolves toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1

ANISOLE

Synonym: Phenyl methyl ether.
Description: Mobile liquid, clear straw color.
Formula: $C_6H_5OCH_3$
Constants:
Mol. Wt. 108.13
M. P. -37.3°C
B. P. 153.8°C
Flash P. 125°F (C.O.C.)
Density 0.996 @18°/4°C
Vap. Press. 10 mm @42.2°C
Vap. D. 3.72
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ANISOYL CHLORIDE

Description: A liquid.
Formula: $CH_3OC_6H_4COCl$
Constants:
Mol. Wt. 170.59
M. P. 27°C
B. P. 145°C @14 mm
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Caution: Can readily evolve hydrochloric acid by hydrolysis.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

ANOGON. See Mercury Compounds and Iodine.

ANSOL M. See Denatured Alcohol.

ANTHRACENE
Synonyms: p-Naphthalene; green oil.
Description: Yellow crystals with blue fluorescence.
Formula: $C_6H_4(CH)_2C_6H_4$
Constants:
Mol. Wt. 178.22
M. P. 217°C
B. P. 345°C
Flash P. 250°F (C.C.)
Density 1.25 @27°/4°C
Autoign. Temp. 881°F
Vap. Press. 1 mm @145.0°C (sublimes)
Vap. D. 6.15
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1; Ingestion 1
Acute Systemic: U
Chronic Local: Irritant 3; Allergen 1
Chronic Systemic: U
Caution: Although it is thought that the pure product is nontoxic, the product as used in industry is thought to be carcinogenic because of contained impurities.
Fire Hazard: Moderate, when exposed to heat or flame; when heated, it emits acrid fumes; reacts with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 0.63% (L.E.L.)
Personal Hygiene: Section 3
Storage and Handling: Section 7

ANTHRACITE PARTICLES
Synonym: Coal dust.
Description: Black powder or dust.
Toxic Hazard Rating:
Acute Local: Inhalation 1
Acute Systemic: 0
Chronic Local: Inhalation 2
Chronic Systemic: 0
MAC: ACGIH (accepted): 50 million particles per cubic foot of air.
Fire Hazard: Moderate, when exposed to heat or flame, or by chemical reaction with oxidizers (Section 6).
Explosion Hazard: Slight, when exposed to flame (Section 7).
Ventilation Control (use normal rate): Section 2

ANTHRALIN
Synonym: 1,8-Dihydroxy anthranol.
Description: Yellow, crystalline powder.
Formula: $C_{14}H_{10}O_3$
Constants:
Mol. Wt. 226.2
M. P. 176 - 181°C
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight, when heated, it emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

ANTHRANILIC ACID
Synonym: o-Amino benzoic acid.
Description: Needle-like crystals.
Formula: $C_6H_4(NH_2)COOH$
Constants:
Mol. Wt. 137.1
M. P. 145°C
B. P. Sublimes
Toxicity: Unknown
Fire Hazard: Slight; on decomposition it emits toxic fumes.
Storage and Handling: Section 7

ANTHRAQUINONE
Description: Powder.
Formula: $C_6H_4(CO)_2C_6H_4$
Constants:
Mol. Wt. 208.20
M. P. 286°C
B. P. 379.9°C
Flash P. 365°F (C.C.)
Density 1.438
Vap. Press. 1 mm @190.0°C
Vap. D. 7.16
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1; Ingestion 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Toxicology: Weak sensitizer. Local contact may cause contact dermatitis (Section 9).

Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

ANTHRAQUINONE BLUE S.R. 1089

Description: A dye.
Toxicity: Weak sensitizer. Local contact may cause contact dermatitis (Section 9).

ANTHRAROBIN

Synonym: 3, 4-Dihydroxy anthranol.
Description: Yellow-brown powder.
Formula: $C_{14}H_{10}O_3$
Constants:
  Mol. Wt. 226.22
  M. P. 208°C
Toxicity: Mild allergen. Local contact may cause contact dermatitis (Section 9).
Fire Hazard: Slight; when heated, it emits smoke (Section 6).
Storage and Handling: Section 7

ANTIFREEZE COMPOUND (LIQUID)

See specific components.
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Combustible liquid; red label.
  Coast Guard Classification: Inflammable liquid; red label.

ANTIFREEZE PREPARATIONS, LIQUID

See specific components.
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Combustible material; red label.
  Coast Guard Classification: Inflammable liquid; red label.

ANTIMONY

Synonyms: Antimony regulus; stibium.
Description: Gray metal.
Formula: Sb
Constants: At. Wt. 121.76
  M. P. 630°C
  B. P. 1380°C
  Density 6.684 @25°C
  Vap. Press. 1 mm @886°C
Toxicity: Highly Toxic. See Antimony Compounds.
MAC: ACGIH (accepted); 0.5 milligrams per cubic meter of air.
Radiation Hazard (Section 5): Artificial isotope Sb^{122}, half-life 2.7 days; emits beta particles of 1.3 and 1.8 mev and gamma rays of 0.57 mev. Artificial isotope Sb^{124}, half-life 60 days; emits 0.57 mev beta (50%) and 2.24 mev beta (50%) and many gamma rays between 0.65-2.0 mev.
Fire Hazard: Moderate, in the form of dust or vapor, when exposed to heat or flame (Section 6). See also Powdered Metals.
Explosion Hazard: Moderate, in the form of dust when exposed to flame (Section 7). See also Powdered Metals.
Disaster Control: Moderately dangerous; when heated or on contact with acid, it emits toxic fumes.

ANTIMONY ARSENATE

Description: Heavy, white powder.
Composition: $Sb_2O_3 + 20\% H_4AsO_7$
Toxicity: See Arsenic and Antimony Compounds.
Disaster Control: See Antimony and Arsenic Compounds.
Storage and Handling: Section 7

ANTIMONY ARSENITE

Description: Fine white powder.
Composition: $Sb_2O_3 + As_2O_3$
Toxicity: See Antimony and Arsenic Compounds.
Disaster Control: See Antimony and Arsenic Compounds.
Storage and Handling: Section 7

ANTIMONY BROMIDE. See Antimony Tribromide.

ANTIMONY CHLORIDE. See Antimony Pentachloride or Antimony Trichloride.

ANTIMONY COMPOUNDS

Toxic Hazard Rating:
  Acute Local: Ingestion 3
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: Irritant 2

Chronic Systemic: Ingestion 3; Inhalation 3
MAC: ACGIH (accepted); 0.5 mg per cubic meter of air.
Toxicology: Because of the association with lead and arsenic in industry, it is often difficult to assess the toxicity of antimony and its compounds. Animals exposed to fumes of antimony oxide have developed pneumonitis, fatty degeneration of the liver, a decreased leucocyte count affecting in particular the polymorphonuclears, and damage to the heart muscle. In humans, complaints referable to the nervous system have been reported. In assessing human cases, however, the possibility of lead or arsenical poisoning must always be borne in mind. Locally antimony compounds are irritant to the skin and mucous membranes.

Signs and symptoms may include irritation and eczematous eruption of the skin, inflammation of the mucous membranes of the nose and throat, metallic taste and stomatitis, gastrointestinal upset, with vomiting and diarrhea, and various nervous complaints, such as irritability, sleeplessness, fatigue, dizziness and muscular and neuralgic pains. See also specific compounds.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ANTIMONY DIOXYSULFATE
Description: White powder.
Formula: $Sb_2O_2SO_4$
Constants:
Mol. Wt. 371.6
Density 4.89
Toxicity: See Antimony Compounds.
Disaster Control: See Antimony.
Storage and Handling: Section 7

ANTIMONY FLUORIDE. See Antimony Pentafluoride or Antimony Trifluoride.

ANTIMONY HYDRIDE
Synonyms: Stibine; hydrogen antimonide.
Description: Colorless gas.
Formula: SbH_3
Constants:
Mol. Wt. 124.78
M. P. −88°C
B. P. −17°C
Density 5.30 g/liter @0°C
Toxic Hazard Rating:
Acute Local: Irritant 0; Inhalation 2
Acute Systemic: Inhalation 3
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (accepted): 0.1 parts per million in air; 0.5 milligrams per cubic meter of air.
Fire Hazard: Moderate, when exposed to flame (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; shock can shatter the compressed gas container; when heated to decomposition, it emits highly toxic fumes; can react vigorously with oxidizing materials.
Ventilation Control (use high rate): Section 2
Storage and Handling: Section 7

ANTIMONY IODIDE. See Antimony Triiodide or Antimony Pentaiodide.

ANTIMONYL PYROGALLOL
Formula:
$HOC_6H_3O(SbOH)O$
Constant:
Mol. Wt. 262.9
Toxicity: An allergen. See also Antimony Compounds.
Disaster Control: See Antimony.
Storage and Handling: Section 7

ANTIMONY alpha-MERCAPTOACETAMIDE
Synonym: Antimony thioglycolamide.
Description: White crystals.
Formula: $Sb(C_2H_4NOS)_3$
Constants:
Mol. Wt. 392.1
M. P. 139°C
Toxicity: See Antimony Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of antimony and oxides of sulfur;
Storage and Handling: Section 7

ANTIMONY OXIDES. See Antimony Trioxide, Antimony Tetraoxide and Antimony Pentaoxide.

ANTIMONY OXYCHLORIDE
Synonyms: Basic antimony chloride; powder of algraoth.
Description: White, amorphous powder.
Formula: SbOCl
Constants:
Mol. Wt. 173.22
M. P. Decomposes @170°C
Toxicity: See Antimony Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.
Storage and Handling: Section 7

ANTIMONY PENTACHLORIDE
Synonyms: Antimonic chloride; antimony perchloride.
Description: Reddish-yellow, oily liquid, offensive odor.
Formula: $SbCl_5$
Constants:
Mol. Wt. 299.05
M. P. 2.8°C
B. P. 140°C
Density (lq) 2.336
Vap. Press. 1 mm @22.7°C
Toxicity: See Antimony Compounds and Hydrochloric Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of antimony and hydrochloric acid; it will react with water or steam to produce heat, toxic or corrosive fumes.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

ANTIMONY PENTAFLUORIDE
Synonym: Antimony fluoride.
Description: Oily, colorless liquid.
Formula: SbF_5
Constants:
Mol. Wt. 216.76
M. P. 71°C
B. P. 149.5°C
Density (lq) 2.99 @23°C
Toxicity: See Fluorides and Antimony Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of fluorides and antimony; it will react with water or steam to produce toxic or corrosive fumes.
Ventilation Control (use high rate).
Shipping Regulations: Section 11
I.C.C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

ANTIMONY PENTAIODIDE
Synonym: Antimony iodide.
Description: Brown solid.
Formula: SbI_5
Constants:
Mol. Wt. 756.4
M. P. 79°C
B. P. 400.6°C
Toxicity: See Antimony Compounds and Iodides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes; it emits highly toxic fumes of iodine and antimony; it will react with water or steam to produce toxic or corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ANTIMONY PENTAOXIDE
Synonym: Antimony pentoxide.
Description: Yellow powder.
Formula: Sb_2O_5
Constants:
Mol. Wt. 323.5
M. P. 380°C (loses an oxygen molecule)
B. P. 930°C (loses 2 oxygen molecules)
Density 3.78
Toxicity: See Antimony Compounds.
Fire Hazard: Moderate, by chemical reaction with reducing agents.
Caution: An oxidizer.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of antimony.
Storage and Handling: Section 7

ANTIMONY PENTASULFIDE

Synonym: Antimony sulfide.
Description: Orange-yellow powder.
Formula: Sb_2S_5
Constants:
Mol. Wt. 403.82
M. P. Decomposes
Density 4.120
Toxicity: See Antimony Compounds and Sulfides.
Fire Hazard: Moderate, when exposed to heat or by chemical reaction with powerful oxidizer.
To Fight Fire: Water (Section 6).
Explosion Hazard: Moderate; when shocked or by spontaneous chemical reaction in contact with powerful oxidizers (Section 7).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur and antimony; it will react with water or steam to produce toxic and flammable vapors; it can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ANTIMONY PENTOXIDE. See Antimony Pentaoxide.

ANTIMONY POTASSIUM OXALATE

Synonym: Potassium-antimony oxalate.
Description: White, crystalline powder.
Formula: $K_3Sb(C_2O_4)_3$
Constant:
Mol. Wt. 503.1
Toxicity: See Antimony Compounds and Oxalates.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of antimony.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ANTIMONY POTASSIUM TARTRATE

Synonyms: Tartar emetic; potassium antimony tartrate.
Description: Colorless crystals; white powder.
Formula: $KSbC_4H_4O_7 \cdot \frac{1}{2}H_2O$
Constants:
Mol. Wt. 333.94
M. P. $-\frac{1}{2}H_2O$ @ 100°C
Density 2.607
Toxicity: See Antimony Compounds.
Caution: This compound is used medicinally but the therapeutic dose is close to the toxic dose. It can cause cough, metallic taste, salivation, nausea and diarrhea. Skin rashes may also occur. Large doses can cause severe damage to the liver.
Disaster Control: See Antimony Compounds.
Storage and Handling: Section 7

ANTIMONY SALT

Synonym: (de Haens salt)
Description: White crystals.
Composition: Mixture of antimony trifluoride and sodium fluoride or ammonium sulfate.
Toxicity: See Antimony Compounds and Fluorides.
MAC: ACGIH (accepted): 2.5 milligrams per cubic meter of air.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of fluorides and antimony.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ANTIMONY SELENIDE. See Antimony Triselenide.

ANTIMONY SULFATE

Synonym: Antimony trisulfate.
Description: White powder.
Formula: $Sb_2(SO_4)_3$
Constants:
Mol. Wt. 531.70
M. P. Decomp.
Density 3.625 @ 4°C
Toxicity: See Antimony Compounds.
Disaster Control: See Antimony.
Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ANTIMONY SULFIDE. See Antimony Pentasulfide or Antimony Trisulfide.

ANTIMONY, SULFURATED
Synonym: Kermes mineral.
Description: Reddish-brown, odorless, tasteless powder.
Composition: 50 - 60%Sb
Toxicity: See Antimony Compounds and Sulfides.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous, when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur and antimony; it will react with water or steam to produce toxic and flammable vapors; on contact with oxidizing materials, it can react vigorously.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ANTIMONY D-TARTRATE
Description: White crystals.
Formula: $Sb_2(C_4H_4O_6)_3 \cdot 6H_2O$
Constant:
Mol. Wt. 795.8
Toxicity: See Antimony Compounds.
Disaster Control: See Antimony
Storage and Handling: Section 7

ANTIMONY TETROXIDE
Synonym: Antimony oxide.
Description: White powder.
Formula: Sb_2O_4
Constants:
Mol. Wt. 307.5
M. P. Loses O_2 @920°C
Density 4.07
Toxicity: See Antimony Compounds.
Disaster Control: See Antimony.
Storage and Handling: Section 7

ANTIMONY THIOGLYCOLAMIDE. See Antimony alpha-Mercaptoacetamide.

ANTIMONY TRIBROMIDE
Synonym: Antimonous bromide.
Description: Yellow, deliquescent, crystalline mass.
Formula: $SbBr_3$
Constants:
Mol. Wt. 361.51
M. P. 96.6°C
B. P. 275°C
Density 4.148
Vap. Press. 1 mm @93.9°C
Toxicity: See Antimony Compounds and Bromides.
Disaster Control: See Antimony.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ANTIMONY TRICHLORIDE
Synonyms: Antimonous chloride; butter of antimony.
Description: Colorless, transparent crystalline mass.
Formula: $SbCl_3$
Constants:
Mol. Wt. 228.13
M. P. 73.4°C
B. P. 219.0°C
Density 3.140 @25°C
Vap. Press. 1 mm @49.2°C (sublimes)
Toxicity: See Antimony Compounds and Hydrochloric Acid.
Disaster Control: See Antimony and Hydrochloric Acid.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ANTIMONY TRIETHYL
Synonym: Triethylstibine.
Description: Liquid.
Formula: $Sb(C_2H_5)_3$
Constant: Mol. Wt. 209.0
Toxicity: See Antimony Compounds.
Fire Hazard: Dangerous, by chemical reaction. Spontaneously flammable in air (Section 6).
Disaster Control: Dangerous; shock can shatter the container with explosive force; when heated to decomposition it burns and emits highly toxic fumes of antimony;

it can react vigorously with oxidizing materials.
Storage and Handling: Section 7

ANTIMONY TRIFLUORIDE
Synonym: Antimony fluoride.
Description: Octagonal crystals.
Formula: SbF_3
Constants:
Mol. Wt. 178.8
M. P. 292°C
B. P. Sublimes
Density 4.379 @ 20.9°C
Toxicity: See Antimony Compounds and Fluorides.
MAC: ACGIH (accepted); 2.5 milligrams per cubic meter of air.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of fluoride and antimony; it will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ANTIMONY TRIIODIDE
Synonym: Antimony iodide.
Description: Red to yellow crystals.
Formula: SbI_3
Constants:
Mol. Wt. 502.5
M. P. 167°C
B. P. 401°C
Density 4.768 @ 22°C
Vap. Press. 1 mm @ 163.6°C
Toxicity: See Antimony Compounds and Iodides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of iodides and antimony; it will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ANTIMONY TRIMETHYL
Synonym: Trimethyl stibine.
Description: Liquid.
Formula: $Sb(CH_3)_3$
Constant:
Mol. Wt. 166.9
Toxicity: See Antimony Compounds.
Fire Hazard: Dangerous, by chemical reaction. Spontaneously flammable in air (Section 6).
Disaster Control: Dangerous; shock can shatter the container with explosive force; when heated to decomposition it emits highly toxic fumes of antimony; it can react vigorously with oxidizing materials.
Storage and Handling: Section 7

ANTIMONY TRIOXIDE
Description: White, odorless, tasteless, crystalline powder.
Formula: Sb_2O_3
Constants:
Mol. Wt. 291.52
M. P. 656°C
B. P. 1550°C (sublimes)
Density 5.2
Vap. Press. 1 mm @ 574°C
Toxicity: See Antimony Compounds.
Disaster Control: See Antimony.
Storage and Handling: Section 7

ANTIMONY TRISELENIDE
Description: Gray powder.
Formula: Sb_2Se_3
Constant:
Mol. Wt. 480.40
Toxicity: See Antimony and Selenium Compounds.
MAC: ACGIH (accepted), as selenium; 0.1 milligrams per cubic meter of air.
Disaster Control: Dangerous; when heated to decomposition or on contact with moisture or acid, it emits highly toxic fumes of antimony and selenium; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

ANTIMONY TRISULFIDE
Synonym: Antimony sulfide.
Description: Red to black crystals.
Formula: SbS_3
Constants:
Mol. Wt. 339.7
M. P. 550°C
Density 4.64

Toxicity: See Antimony Compounds and Sulfides.
Fire Hazard: Moderate, by spontaneous chemical reaction in contact with strong oxidizers (Section 6).
Explosion Hazard: Moderate, by spontaneous chemical reaction in contact with chlorates, perchlorates (Section 7).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur and antimony; it will react with water or steam to produce toxic and flammable vapors; it can react vigorously with oxidizing materials.
Storage and Handling: Section 7

ANTIMONY TRITELLURIDE

Synonym: Antimony telluride.
Description: Gray powder.
Formula: Sb_2Te_3
Constants:
Mol. Wt. 626.4
M. P. 629°C
Toxicity: See Antimony and Tellurium Compounds.
Fire Hazard: Moderate, by chemical reaction in contact with strong oxidizers (Section 6).
Explosion Hazard: Moderate, by chemical reaction in contact with chlorates and perchlorates (Section 7).
Disaster Control: Dangerous when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of antimony and tellurium; it will react with water or steam to produce toxic and flammable vapors; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

ANTIPYRINE

Synonym: Phenozone.
Description: Fine white, crystalline powder.
Formula: $C_{11}H_{12}N_2O$
Constants:
Mol. Wt. 188.23
M. P. 113°C
B. P. 319°C @174 mm
Density 1.19
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 1
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ANTISEPTIC OIL

Synonym: Hydroquinone in oil.
Description: Liquid.
Toxicity: A weak sensitizer. Local contact may cause contact dermatitis (Section 9).
Fire Hazard: A combustible material. When heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

APACHE COAL POWDERS. See Explosives, High.

APOATROPINE

Synonym: Atopamine.
Description: White powder.
Formula: $C_{17}H_{21}NO_2$
Constants:
Mol. Wt. 271.35
M. P. 62°C
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: 0
Chronic Systemic: U
Toxicology: A poisonous alkaloid, which causes a marked conjunctivitis. See also Atropine.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

APOATROPINE HYDROCHLORIDE. See Atropine.

APOATROPINE SULFATE. See Atropine.

APOCODEINE
Description: White crystalline solid.
Formula: $C_{18}H_{19}NO_2$
Constants:
Mol. Wt. 281.34
M. P. 100 - 110°C (Decomp.)
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Allergen 1
Chronic Systemic: U
Toxicology: A poisonous alkaloid. See also Codeine. Weak sensitizer. Local contact may cause contact dermatitis (Section 9).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

APOCODEINE HYDROCHLORIDE
See Apocodeine.

APOMORPHINE
Description: White crystalline alkaloid.
Formula: $C_{17}H_{17}NO_2$
Constants:
Mol. Wt. 267.32
M. P. 170°C (Decomp.)
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Allergen 1
Chronic Systemic: U
Caution: Small doses cause depression while large doses produce excitement, convulsions and death. A powerful emetic. A weak sensitizer. Local contact may cause contact dermatitis (Section 9). Mild symptoms require no treatment, but stimulants such as coffee or caffeine may be given. For severe cases, chloral hydrate, chloroform or ether. Call a physician.
Disaster Control: Dangerous, when heated to decomposition, it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personel Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

APOMORPHINE HYDROCHLORIDE.
See Apomorphine.

AQUAMARINE. See Beryl.

AQUAPHOR
Toxicity: An allergen. Weak sensitizer. Local contact may cause contact dermatitis (Section 9).

AQUA REGIA
Synonym: Nitro hydrochloric acid.
Description: Fuming yellow, corrosive, suffocating volatile liquid.
Composition: (U.S.P.): 18 cc HNO_3 plus 82 cc HCl
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: Irritant 2
Chronic Systemic: U
Fire Hazard: Moderate by chemical reaction with easily oxidized materials (Section 6).
Caution: A powerful oxidizer.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of nitrosyl chloride; can react vigorously with reducing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ARECA NUT.
Synonym: Betel.
Description: Brown, mottled with fawn color.
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Ingestion 1
Chronic Local: 0
Chronic Systemic: U
Fire Hazard: Slight, when heated, it emits acrid fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

ARECOLINE BASE

Synonym: Methyl 1, 2, 5, 6-tetrahydro-1-methyl nicotinate.
Description: Oily liquid.
Formula: $C_8H_{13}NO_2$
Constants:
  Mol. Wt. 155.2
  B. P. 209°C
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Combustible liquid (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes; it can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ARGON

Description: Colorless, inert gas.
Formula: A
Constants:
  At. Wt. 39.94
  M. P. −189.2°C
  B. P. −185.7°C
  Density 1.784 g/liter @0°C; lq. 1.40 @−186°C cr. 1.65 @−233°C
Toxic Hazard Rating:
  Acute Local: 0
  Acute Systemic: Inhalation 1
  Chronic Local: U
  Chronic Systemic: U
Toxicology: Classified as a simple asphyxiant gas. Gases of this type have no specific toxic effect, but they act by excluding oxygen from the lungs. The effect of simple asphyxiant gases is proportional to the extent to which they diminish the amount (partial) pressure) of oxygen in the air that is breathed. The oxygen may be diminished to two-thirds of its normal percentage in air before appreciable symptoms develop and this in turn requires the presence of a simple asphyxiant in a concentration of 33 percent in the mixture of air and gas. When the simple asphyxiant reaches a concentration of 50 percent, marked symptoms can be produced. A concentration of 75 percent is fatal in a matter of minutes.

The first symptoms produced by simple asphyxiant gases, such as argon, are rapid respirations and air hunger. Mental alertness is diminished and muscular coordination is impaired. Later, judgment becomes faulty and all sensations are depressed. Emotional instability often results and fatigue occurs rapidly. As the asphyxia progresses, there may be nausea and vomiting, prostration and loss of consciousness, and finally, convulsions, deep coma and death.

Radiation Hazard: Artificial isotope A^{41}, half-life, 1.8 hours; emits beta particles of 1.3 mev and gamma rays of 1.3 mev. The permissible levels are: In body: 30 microcuries. In air: 5×10^{-7} microcurie per milliliter. In water: 5×10^{-4} microcurie per milliliter.
Caution: Although A^{41} has a short half-life, it may present a slight hazard as an effluent from nuclear reactors where it is formed by neutron bombardment of A^{40}, the most abundant natural isotope.
Disaster Control: Moderately dangerous; shock can shatter the compressed gas container with explosive force.
Ventilation Control (use optional): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Nonflammable gas; green label.
  Coast Guard Classification: Noninflammable gas; green gas label.

ARGYROL

Synonym: Mild silver protein.
Description: Brown to black crystals.
Composition: 19 - 23% Silver
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: 0

Chronic Local: Allergen 1
Chronic Systemic: Ingestion 1
Caution: Continued application can cause argyria. See also Silver Compounds. Local contact may cause contact dermatitis (Section 9).
Personal Hygiene: Section 3

ARICYL ACID

Synonym: Arsonoacetic acid.
Description: Crystals.
Formula: $C_2H_5AsO_5$
Constant:
Mol. Wt. 184.1
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

ARNICA

Synonyms: Wolfsbane; mountain tobacco.
Description: An alcoholic infusion.
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 1; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 3; Skin Absorption 3
C Chronic Local: Allergen 1
Chronic Systemic: U
Caution: Overdose can be fatal. It can cause gastroenteritis, nervous disturbances and collapse. Local contact may cause contact dermatitis (Section 9).
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

AROMATIC SPIRITS OF AMMONIA

Synonym: Spirit of Hartshorn.
Description: Colorless liquid, suffocating odor of ammonia.
Composition: 10% by weight of NH_3 in alcohol.
Toxic Hazard Rating:
Acute Local: Ingestion 1; Inhalation 1
Acute Systemic: Ingestion 1; Inhalation 1
Chronic Local: 0
Chronic Systemic: U
Fire Hazard: Dangerous, in its usual form (solution of NH_3 in alcohol)(Section 6).
Explosion Hazard: Moderate, in its usual form (Section 7).
Disaster Control: Moderately dangerous; when heated it emits toxic fumes of ammonia; it can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

ARSACETIN (SODIUM SALT)

Synonym: Sodium acetylarsanilate.
Description: White crystalline powder, odorless, tasteless.
Formula: $C_8H_9O_4NaNAs + 4H_2O$
Constant:
Mol. Wt. 353
Toxicity: See Arsenic Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of arsenic.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ARSANILIC ACID

Synonyms: Antoxylic acid; aminophenylarsine acid.
Description: White, crystalline powder.
Formula: $NH_2C_6H_4AsO(OH)_2$
Constants:
Mol. Wt. 217.0
M. P. 232°C
Toxicity: A grasshopper bait. See Arsenic Compounds and Aniline.
Fire Hazard: Moderate. Decomposed by heat to yield flammable vapors.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of aniline and arsenic.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ARSANILIN ACID. See Arsanilic Acid.

ARSENATE OF IRON, FERRIC. See Ferric Arsenate.

ARSENATE OF IRON, FERROUS. See Ferrous Arsenate.

ARSENIC. (See also Arsenic Vapor.)
Description: Silvery, brittle, crystalline metal.
Formula: As_4
Constants:
Mol. Wt. 299.64
M. P. 814°C @36 atm.
B. P. Sublimes @615°C
Density Black crystals 5.724 @ 14°C; black amor. 4.7
Vap. Press. 1 mm @372°C (sublimes)
Toxicity: Highly toxic. See Arsenic Compounds.
Radiation Hazard (Section 5): Artificial isotope As^{76}, half-life 26 hours; emits beta particles of 1.4 mev (20%); 2.5 mev (20%); 3.1 mev (60%) and gamma rays between 0.57-1.2 mev. The permissible levels are: In body: 10 microcuries. In air: 2×10^{-6} microcurie per milliliter. In water: 0.2 microcurie per milliliter. Artificial isotope As^{77}, half-life 40 hours emits e^- particles of 0.7 mev.
Hazard Rating: Class I (National Bureau of Standards Handbook No. 42).
Fire Hazard: Moderate in the form of dust when exposed to heat or flame or by chemical reaction with powerful oxidizers (Section 6).
Explosion Hazard: Slight in the form of dust when exposed to flame (Section 7).
Disaster Control: Dangerous; when heated or on contact with acid or acid fumes, it emits highly toxic fumes; it can react vigorously on contact with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

m-ARSENIC ACID
Description: White crystals.
Formula: $HAsO_3$
Constants:
Mol. Wt. 123.9
M. P. Decomposes
Toxic Hazard Rating: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

o-ARSENIC ACID
Synonyms: True arsenic acid.
Description: White, translucent crystals.
Formula: $H_3AsO_4 \cdot {}^1/_2H_2O$
Constants:
Mol. Wt. 150.9
M. P. 35.5°C
B. P. $-H_2O$ @160°C
Density 2.0 - 2.5
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

ARSENIC ACID, LIQUID. See Arsenic Acid.
Shipping Regulations: Section 11.
I.C.C. Classification: Poison B poison label.
Coast Guard Classification: Poison B; poison label.

ARSENICAL BABBITT
Description: A bearing metal.

Composition: Up to 3% As
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ARSENICAL COMPOUNDS OR MIXTURES, N.O.S. LIQUID

Toxicity: See Arsenic Compounds.
Shipping Regulations: Section 11.
  I.C.C. Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.

ARSENICAL DIP, LIQUID

Synonym: Sheep dip.
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Shipping Regulations: Section 11.
  I.C.C. Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.

ARSENICAL DUST. See Arsenic.
Shipping Regulations: Section 11.
  I.C.C. Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.

ARSENICAL FLUE DUST. See Arsenic.
Shipping Regulations: Section 11.
  I.C.C. Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.

ARSENICAL MIXTURES OR COMPOUNDS, N.O.S. SOLID. See Arsenic Compounds.
Shipping Regulations: Section 11.
  I.C.C. Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.

ARSENIC BISULFIDE

Synonym: Arsenic sulfide; realgar.
Description: Red-brown crystals.
Formula: As_2S_2
Constants: Mol. Wt. 214
  B.P. 565°C
  M. P. $\beta = 307°C$
  Density $\alpha = 3.506$ @19°C; $\beta = 3.254$ @19°C
Toxicity: See Arsenic Compounds and Sulfides.
Fire Hazard: Moderate, in the form of dust when exposed to heat or flame (Section 6).
Explosion Hazard: Slight, when intimately mixed with powerful oxidizers (Section 7).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur and arsenic; it will react with water or steam to produce toxic and flammable vapors; it can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ARSENIC BROMIDE

Synonyms: Arsenic tribromide; arsenous bromide.
Description: Yellowish-white crystals.
Formula: $AsBr_3$
Constants:
  Mol. Wt. 314.7
  M. P. 32.8°C
  B. P. 220.0°C
  Density 3.54 @ 25°C
  Vap. Press. 1 mm @41.8°C
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.

ARSENIC CHLORIDE. See Arsenic Pentachloride.

Shipping Regulations: Section 11.
I. C. C. Classification: (Arsenous, liq.) Poison B; poison label.
Coast Guard (Arsenous, liq.) Poison B; poison label.

ARSENIC COMPOUNDS. See also specific compound.
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 2; Ingestion 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Irritant 2; Allergen 2
Chronic Systemic: Ingestion 3; Inhalation 3
MAC: ACGIH (accepted); 0.5 milligrams per cubic meter of air.
Toxicology: Poisoning from arsenic compounds may be acute or chronic. Acute poisoning usually results from swallowing arsenic compounds; chronic poisoning from either swallowing or inhalation. Acute allergic reactions to arsenic compounds used in medical therapy have been fairly common. The type and severity of the reaction depending upon the compound of arsenic.

Acute arsenic poisoning (from ingestion) results in marked irritation of the stomach and intestines with nausea, vomiting and diarrhea. In severe cases the vomitus and stools are bloody and the patient goes into collapse and shock with weak, rapid pulse, cold sweats, coma and death.

Chronic arsenic poisoning, whether through ingestion or inhalation, may manifest itself in many different ways. There may be disturbances of the digestive system such as loss of appetite, cramps, nausea, constipation or diarrhea. Liver damage may occur, resulting in jaundice. Disturbances of the blood, kidneys and nervous system are not infrequent. Arsenic can cause a variety of skin abnormalities including itching, pigmentation and even cancerous changes. A characteristic of arsenic poisoning is the great variety of symptoms that can be produced.

In treating acute poisoning from ingestion the contents of the intestinal tract should be evacuated promptly by gastric lavage and saline cathartics. BAL (dimercaptol) is highly effective in both acute and chronic poisoning (Section 1).
Disaster Control: Dangerous; when heated to decomposition or on contact with acids or acid fumes, they emit highly toxic fumes of arsenic.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1

ARSENIC COPPER. See Copper Arsenide.

ARSENIC DIETHYL
Synonyms: Ethyl cacodyl; tetraethyl diarsine.
Description: Liquid or oil.
Formula: $(As(C_2H_5)_2)_2$
Constants:
Mol. Wt. 266.2
B. P. 185 - 190°C
Density About 1
Toxicity: See Arsenic Compounds.
Fire Hazard: Dangerous, by spontaneous chemical reaction (Section 6). A spontaneously flammable liquid.
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of arsenic; it can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ARSENIC DIIODIDE
Synonym: Arsenic iodide.
Description: Red crystals.
Formula: AsI_2
Constants:
Mol. Wt. 328.8
M. P. Decomposes @136°C
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.

Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ARSENIC DIMETHYL
Synonym: Tetramethyl diarsyl.
Description: Colorless to yellow oily liquid.
Formula: $(As(CH_3)_2)_2$
Constants:
  Mol. Wt. 210.0
  M. P. -6°C
  B. P. 186°C
  Density 1.15
Toxicity: See Arsenic Compounds.
Fire Hazard: A moderately flammable liquid (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of arsenic.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ARSENIC DISULFIDE. See Arsenic Bisulfide.

ARSENIC FLUORIDE. See Arsenic Pentafluoride or Arsenic Trifluoride.

ARSENIC HEMISELENIDE
Description: Black crystals with metallic luster.
Formula: As_2Se
Constant:
  Mol. Wt. 228.78
Toxicity: See Arsenic Compounds and Selenium Compounds.
MAC: ACGIH (accepted), as selenium. 0.1 milligram per cubic meter of air.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of arsenic and selenium; it can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ARSENIC IODIDE. See Arsenic Diiodide.
Shipping Regulations: Section 11.
  I. C. C. Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.

ARSENIC OXIDES. See Arsenic Trioxide or Arsenic Pentoxide.

ARSENIC OXYCHLORIDE
Description: Brown crystals.
Formula: AsOCl
Constants:
  Mol. Wt. 126.4
  B. P. Decomposes
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ARSENIC PENTACHLORIDE
Description: Colorless liquid.
Formula: $AsCl_5$
Constants:
  Mol. Wt. 252.2
  M. P. -40°C (approx.)
Toxicity: See Arsenic Compounds and Hydrochloric Acid.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of hydrochloric acid and arsenic; it will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ARSENIC PENTAFLUORIDE
Synonym: Arsenic fluoride.
Description: Colorless gas.
Formula: AsF_5
Constants:
  Mol. Wt. 169.9

M. P. -80°C
B. P. -53°C
Density 7.71 g/liter
Toxicity: See Arsenic Compounds and Fluorides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides and arsenic; it will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ARSENIC PENTASELENIDE

Description: Black, brittle solid with a metallic luster.
Formula: As_2Se_5
Constant:
Mol. Wt. 544.62
Toxicity: See Arsenic and Selenium Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of arsenic and selenium.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ARSENIC PENTASULFIDE

Description: Brownish-yellow, glassy amorphous, highly refractive mass.
Formula: As_2S_5
Constant:
Mol. Wt. 310.12
Toxicity: See Arsenic Compounds and Sulfides.
Fire Hazard: A flammable material (Section 6).
Explosion Hazard: See Sulfides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur and of arsenic; it will react with water or steam to produce toxic and corrosive fumes; it can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ARSENIC PENTOXIDE

Synonym: Arsenic oxide.
Description: White, amorphous solid. Deliquescent.
Formula: As_2O_5
Constants:
Mol. Wt. 229.8
M. P. 315°C (decomp.)
Density 4.086
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Shipping Regulations: Section 11.
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

ARSENIC PHOSPHIDE

Description: Brown to red powder.
Formula: AsP
Constants:
Mol. Wt. 105.9
M. P. Sublimes with decomp.
Toxicity: See Arsenic Compounds and Phosphides.
Fire Hazard: Moderate, by spontaneous chemical reaction. Phosphine is liberated upon contact with moisture (Section 6).
Explosion Hazard: Details unknown.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of phosphorus and of arsenic; it will react with water or steam to produce toxic and flammable vapors; it can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ARSENIC SULFIDE (POWDER)
See Arsenic Trisulfide, Arsenic Bisulfide and Arsenic Pentasulfide.
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

ARSENIC TRICHLORIDE
Description: Clear, almost colorless to pale yellow corrosive oily liquid, or needle-like crystals.
Formula: $AsCl_3$
Constants:
Mol. Wt. 181.3
M. P. −18°C
B. P. 130.2°C
Density (liquid) 2.163 @14°/4°C
Vap. Press. 10 mm @23.5°C
Vap. D. 6.25
Toxicity: See Arsenic Compounds and Hydrochloric Acid.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of hydrochloric acid and of arsenic; it will react with water or steam to produce heat, toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.
MCA warning label.

ARSENIC TRIETHYL. See Triethyl Arsenic.

ARSENIC TRIFLUORIDE
Synonym: Arsenic fluoride.
Description: Oily liquid.
Formula: AsF_3
Constants:
Mol. Wt. 131.9
M. P. −5.9°C
B. P. 63°C @752 mm
Density (liquid) 2.666
Vap. Press 100 mm @13.2°C; 400 mm @41.5°C
Toxicity: See Arsenic Compounds and Fluorides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of fluorides and of arsenic; it will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ARSENIC TRIMETHYL. See Trimethyl Arsenic.

ARSENIC TRIOXIDE
Synonyms: Arsenious oxide; white arsenic.
Description: White, odorless, tasteless, amorphous powder.
Formula: As_2O_3
Constants:
Mol. Wt. 197.8
M. P. 193°C (sublimes)
Density (Arsenalite) 3.865 @25°C; (Claudedite) 4.15; (Amorphous) 4.09
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

ARSENIC TRIPHENYL. See Triphenyl Arsenic.

ARSENIC TRISELENIDE
Synonym: Arsenic selenide.
Description: Brown crystals.
Formula: As_2Se_3
Constants:
Mol. Wt. 386.7
M. P. 360°C
Density 4.75

Toxicity: See Arsenic Compounds and Selenium Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of selenium and arsenic; it can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ARSENIC TRISULFIDE

Synonym: Arsenic sulfide; orpiment.
Description: Yellow or red crystals.
Formula: As_2S_3
Constants: Mol. Wt. 246.0
M. P. 300°C
B. P. 707°C
Density 3.43
Toxicity: See Arsenic Compounds and Sulfides.
Fire Hazard: See Sulfides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of sulfur and of arsenic; it will react with water or steam to produce toxic and flammable vapors; it can react vigorously on contact with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ARSENIC VAPOR

Description: A vapor.
Formula: As
Constant:
At. Wt. 75
Toxicity: See Arsenic Compounds.
MAC: ACGIH (accepted); 0.5 milligram per cubic meter of air.
Fire Hazard: Moderate, by chemical reaction with oxidizers (Section 6).
Disaster Control: See Arsenic.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1

ARSENIOUS SELENIDE. See Arsenic Triselenide.

ARSENOUS ACID, SOLID. See Arsenic Trioxide.
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

ARSENOUS AND MERCURIC IODIDE SOLUTION, LIQUID

Description: Liquid.
Toxicity: See Arsenic Compounds and Mercury Compounds.
Disaster Control: See Arsenic and Mercury Compounds.
Ventilation Control: Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

ARSINE

Synonyms: Arsenic hydride; arseniuretted hydrogen.
Description: Colorless gas, mild garlic odor.
Formula: AsH_3
Constants:
Mol. Wt. 77.93
M. P. -116.3°C
B. P. -55°C
Density 3.484 g/liter
Vap. D. 2.66
Toxic Hazard Rating:
Acute Local: Inhalation 3
Acute Systemic: Inhalation 3
Chronic Local: U
Chronic Systemic: Inhalation 3
MAC: ACGIH (accepted); 0.05 parts per million in air.
Toxicology: The toxicity of arsine is due to its hemolytic action. On entering the blood stream it combines with the hemoglobin of the red blood cells; gradually the arsenic in this hemoglobin-arsenic complex is oxidized, and the oxidation process is accompanied by hemolysis of the cell. The

resulting anemia is responsible for the production of many of the symptoms accompanying arsine poisoning; other symptoms result from the hemolysis itself, and occur during the excretion of the hemoglobin. Hemoglobin and its degradation products are commonly found in the urine. Less commonly whole blood may be passed. Occasionally, the renal tubules may be plugged by debris, with resultant suppression of urine. Jaundice, which may be severe, is a common result of the hemolysis. Frequently there is edema of the lungs, which may be accompanied by cyanosis. Kidney damage is common in patients surviving acute affects of the gas.

Signs of poisoning usually develop within several hours of exposure. Headache, dizziness, nausea and vomiting, epigastric pain and weakness occur early, followed by tea-colored urine, or bloody urine in the more severe cases. Some time later, albumen and casts may appear in the urine, or, in serious cases, there may be suppression of urine. Jaundice and tenderness over the liver may appear about the same time. Blood examination shows an anemia which may be marked. In fatal cases, the patient may develop delirium, followed by coma and death. During the acute stage of poisoning and for some weeks after, arsenic may be demonstrated in the urine. See also Arsenic and Arsenic Compounds.

Fire Hazard: Moderate, when exposed to flame (Section 6).
Explosion Hazard: Moderate when exposed to flame (Section 7).
Disaster Control: Dangerous; when heated to decompositon, it emits highly toxic fumes of arsenic; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

ARSPHENAMINE

Synonym: 3-Diamino-4-dihydroxy-1-arsenobenzene hydrochloride.
Description: Light yellow, hygroscopic powder.
Formula: $C_{12}H_{12}As_2N_2O_2 \cdot 2HCl \cdot 2H_2O$
Constant:
Mol. Wt. 475.0
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ASBESTOS PARTICLES

Synonym: Asbestos dust.
Toxic Hazard Rating:
Acute Local: Irritant 1; Inhalation 2
Acute Systemic: 0
Chronic Local: Inhalation 3
Chronic Systemic: U
MAC: ACGIH (accepted); 5 million particles per cubic foot of air.
Toxicology: The essential lesion produced by asbestos dust is a diffuse fibrosis which probably begins as a "collar" about the terminal bronchioles. Usually, at least 4 to 7 years of exposure are required before a serious degree of fibrosis results. There is apparently less predisposition to tuberculosis than is the case with silicosis.

Clinically, the most striking sign is shortness of breath of gradually increasing intensity, often associated with a dry cough. In the early stages physical signs are absent or slight; in the later stages rales may be heard, and in long-standing cases there is frequently clubbing of the fingers. In early stages of the disease the chest x-ray reveals a ground-glass or granular change, chiefly in the lower lung fields; as the condition progresses the heart outline becomes "shaggy" and irregular patches of mottled shadowing may be seen. Asbestos bodies may be found in the sputum.

At autopsy, the pleurae are thickened and adherent and thick subpleural fibrous plaques are often present. Where the disease is far advanced there are usually

large areas of fibrosis, with emphysematous changes in the apices and bases. The alveolar walls are thickened, and the characteristic "asbestos bodies" are found.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

ASCARIDOLE
Description: Liquid.
Formula: $C_{10}H_{16}O_2$
Constants:
Mol. Wt. 168.2
B. P. 115°C @15 mm
Density 1.011 @13°/15°C
Toxicity: Details unknown. See also Peroxides, Organic.
Fire Hazard: Moderate, by spontaneous chemical reaction (Section 6).
Caution: An oxidizer.
Explosion Hazard: Explodes at 250°C.
Disaster Control: Dangerous; when heated, it emits toxic fumes and may explode; it reacts with reducing materials.
Storage and Handling: Section 7

ASPHALT
Synonyms: Bitumen; petroleum pitch.
Description: Black or dark brown mass.
Constants:
B. P.: < 470°C
Flash P. 400+°F (C.C.)
Density 0.95 - 1.1
Autoign. Temp. 905°F
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: U
Chronic Local: Irritant 2
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Hazardous Article.

ASPIDIUM
Synonym: Male fern.
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1
Acute Systemic: Ingestion 2
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

ASPIRIN. See Acetol.

ATABRINE DIHYDROCHLORIDE. See "Atabrine" Hydrochloride.

"ATABRINE" HYDROCHLORIDE
Synonym: Quinacrine hydrochloride.
Description: Bright yellow crystals.
Formula: $C_{23}H_{30}ClN_3O \cdot 2HCl \cdot 2H_2O$
Constants:
Mol. Wt. 508.9
M. P. Decomposes 248 - 250°C
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: Ingestion 2
Chronic Local: Allergen 1
Chronic Systemic: Ingestion 2
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorine.
Personal Hygiene: Section 3
Storage and Handling: Section 7

ATROPINE
Synonym: Daturine.
Description: Colorless, crystalline alkaloid.
Formula: $C_{17}H_{23}NO_3$
Constants:
Mol. Wt. 289.4
M. P. 115.5°C; sublimes at 118°C
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Allergen 1
Chronic Systemic: Ingestion 2
Fire Hazard: Slight; on decomposition it emits toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ATROPINE METHYL BROMIDE. See Atropine.

ATROPINE METHYL NITRATE. See Atropine.

ATROPINE SULFATE. See Atropine.

AURIC BROMIDE
Description: Gray powder; crystals brown.
Formula: $AuBr_3$
Constants:
Mol. Wt. 436.95
M. P. $-Br_2$ @ 160°C
Toxicity: See Gold Compounds and Bromides.
Disaster Control: See Bromides.
Storage and Handling: Section 7

AURIC CHLORIDE
Synonym: Gold chloride.
Description: Claret red crystals.
Formula: $AuCl_3$
Constants:
Mol. Wt. 303.57
M. P. 254°C decomposes
B. P. Sublimes 265°C
Density 3.9
Toxicity: See Gold Compounds.
Disaster Control: See Chlorides.
Storage and Handling: Section 7

AURIC CYANIDE
Synonym: Cyanoauric acid.
Description: Colorless, hygroscopic plates.
Formula: $Au(CN)_3 \cdot 3H_2O$
Constants:
Mol. Wt. 329.30
M. P. Decomposes 50°C
Toxicity: Highly toxic. See Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

AURIC HYDROGEN NITRATE
Synonym: Gold nitrate.
Description: Yellow crystals.
Formula: $AuH(NO_3)_4 \cdot 3H_2O$
Constants:
Mol. Wt. 500.29
M. P. 72°C decomposes
Density 2.84
Toxicity: See Gold Compounds and Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

AURIC IODIDE
Synonym: Gold iodide.
Description: Dark green crystals.
Formula: AuI_3
Constant:
Mol. Wt. 577.96
Toxicity: See Gold Compounds.
Storage and Handling: Section 7

AURIC OXIDE
Synonym: Gold oxide.
Description: Brown black powder.
Formula: Au_2O_3
Constants:
Mol. Wt. 442.40
M. P. $-O_2$ @ 160°C
B. P. $-3O_2$ @ 250°C
Toxicity: See Gold Compounds.

AURIC SULFIDE
Synonym: Gold sulfide.
Description: Brown black powder.
Formula: Au_2S_3
Constants:
Mol. Wt. 490.60
M. P. Decomposes 197°C
Density 8.754
Toxicity: See Gold Compounds and Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

AUROUS BROMIDE
Description: Yellowish-gray mass or crystalline powder.
Formula: AuBr
Constants:
Mol. Wt. 277.12
M. P. Decomposes 115°C
Density 7.9
Toxicity: See Gold Compounds and Bromides.
Storage and Handling: Section 7

AUROUS CHLORIDE
Description: Yellow crystals.
Formula: AuCl
Constants:
Mol. Wt. 232.66
M. P. Decomposes to $AuCl_3$ @ 170°C
B. P. Decomposes 289.5°C
Toxicity: See Gold Compounds.

AUROUS CYANIDE
Synonym: Gold cyanide.
Description: Light yellow, crystalline powder.
Formula: AuCN

Constants: Mol. Wt. 223.22
M. P. Decomposes
Density 7.12
Toxicity: Highly toxic. See Cyanides and Gold Compounds.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

AUROUS IODIDE

Description: Greenish-yellow powder.
Formula: AuI
Constants: Mol. Wt. 324.12
M. P. Decomposes 120°C
Density 8.25
Toxicity: See Gold Compounds.
Storage and Handling: Section 7

AUROUS OXIDE

Description: Gray-violet crystals.
Formula: Au_2O
Constants: Mol. Wt. 410.4
M. P. $-O_2$ @ 205°C
Density 3.6
Toxicity: See Gold Compounds.

AUROUS SULFIDE

Description: Brown black powder.
Formula: Au_2S
Constants: Mol. Wt. 426.47
M. P. Decomposes 240°C
Toxicity: See Gold Compounds and Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

AUSTEN RED DIAMONDS. See Explosives, High.

AUTUNITE

Synonyms: Calco uranite; lime uranite.
Description: Bright yellow mineral of pearly luster.
Formula: $Ca(UO_2)_2P_2O_8 \cdot 8H_2O$
Toxicity: See Uranium Compounds, Insoluble.
Radiation Hazard: See Uranium.

AVERTIN. See Tribromoethanol.

AZELAIC ACID

Description: Powder.
Formula: $HOOC(CH_2)_7COOH$
Constants: Mol. Wt. 188.22
M. P. 106.5°C
B. P. 356.5°C (decomposes)
Density 1.038 @ 110°C
Vap. Press. 1 mm @ 178.3°C
Toxicity Hazard: Unknown
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

AZIDES (See also specific compound.)
Toxicity: Variable
Fire Hazard: Unknown
Explosion Hazard: Severe when shocked or exposed to heat (Section 7).

An azide is a compound of hydrogen or a metal and the monovalent $-N_3$ radical. The azides as a group are one of the few commercially produced explosives that contain no oxygen. Hydrogen azide or azoic acid and its sodium salt are soluble in water. All of its salts and the acid are unstable and decompose explosively; although lead azide, which is one of the most important azides, is not very sensitive and is used as a detonating agent, in which respect it is more efficient, weight for weight than fulminate. Azides can be used wherever fulminate may be used; in detonators and priming compositions as well. Their only drawbacks are their high ignition temperature (detonators) and relative insensitiveness to friction (priming compositions). However, by compounding them with other materials, this can be overcome. Mercury azide, however, is more sensitive than lead azide; in fact it is more sensitive than mercury fulminate. When packed in bulk, azide should contain not less than 20 percent of water and in this wet condition should be placed in bags of four-ounce or heavier duck. Each bag contains approximately 25 pounds, dry weight, of lead azide. In each bag and over the azide is placed a cap of the same cloth and of the diameter of the bag, and the bag is tied securely. Five of these bags are placed in a larger bag of four-ounce or heavier duck and this large bag is tied securely. The large bag should contain not more than 150 pounds, dry weight of lead azide. This bag is placed in the center of a container complying with ICC specification 5 or 5B (pertaining to metal barrels or drums) 17H (pertaining to metal drums, single trip) or 10B (pertaining to wooden barrels or kegs). The container is lined with a heavy close fitting bag of jute or other suitable bag material of equal strength. The large duck bag is completely surrounded within the jute bag by not less than 3 inches of well-packed sawdust, saturated with water and the jute bag is closed by securely sewing to prevent escape of sawdust. The outer container, drum, or barrel is water-tight. When considered necessary to prevent freezing in shipment, or storage, an alternative method of packing is used. The lead azide is wet with not less than 20 percent of its weight of a solution of denatured ethyl alcohol in water containing not less than 33 percent by weight of ethyl alcohol. The 25 pound duck bags are placed in a strong waterproof bag instead of a duck bag and the drum or barrel is filled with sawdust saturated with the same 33 percent by weight solution of ethyl alcohol. Marking should be in accordance with U.S. Standard Specification for marking shipment #100-2. In addition, each barrel or cask is marked plainly "INITIATING EXPLOSIVE - DANGEROUS DO NOT STORE OR LOAD WITH ANY HIGH EXPLOSIVE." For further information concerning surface storage and the destruction of excess azide explosives, see Section 7.

Lead and mercury azides are the best examples of the azide type of explosive. Further uses of azide are in loading of fuse detonators and in the manufacture of priming compositions. Azides are used as substitutes for mercury fulminate. On account of its high temperature of ignition, lead azide is not easily ignited by the "spit" of a safety fuse. However, the addition of lead styphnate for instance, which is more readily ignited, overcomes the difficulty. It is also used in explosive rivets with the addition of silver acetylide or tetracine to lower its ignition temperature.

Disaster Control: Dangerous; shock and heat will explode it and when heated to decomposition, it emits highly toxic fumes.

Storage and Handling: Section 7

AZOBENZENE

Synonyms: Azobenzol; azobenzide.
Description: Solid, orange-red crystals.
Formula: $C_6H_5NNC_6H_5$
Constants: Mol. Wt. 182.2
M. P. 68°C
Density 1.203 @20°/4°C
Vap. Press. 1 mm @103.5°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U

AZOCHLORAMIDE

Synonym: Chloroazodin.
Description: Bright-yellow crystals.
Formula: $C_2H_4Cl_2N_6$
Constants: Mol. Wt. 183.0
M. P. Explodes decomp. @155°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Explosion Hazard: Moderate, when exposed to heat (Section 7).
Explosive Range: At 155°C
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes and may explode.
Personal Hygiene: Section 3
Storage and Handling: Section 7

AZOXYBENZENE

Synonym: Azoxybenzide.
Description: Pale yellow crystals.
Formula: $C_{12}H_{10}N_2O$
Constants:
Mol. Wt. 198.2
M. P. 36°C
Density 1.159 @26°/4°C
Toxicity: Details unknown; an insecticide.
Fire Hazard: Slightly dangerous; on decomposition it emits toxic fumes (Section 6).
Storage and Handling: Section 7

B

BAGASSE DUST

Toxic Hazard Rating:
  Acute Local: Irritant 2; Inhalation 2
  Acute Systemic: 0
  Chronic Local: Inhalation 2
  Chronic Systemic: Inhalation 2
MAC: ACGIH (accepted); 50 million particles per cubic foot of air.
Caution: A nuisance dust; inhalation can cause bronchial asthma, sneezing, rhinorrhea, eczema, etc. (Section 9).
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: Moderate, when exposed to flame. See Dust Explosions.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

BAGS, NITRATE OF SODA, EMPTY AND UNWASHED

See also Sodium Nitrate.
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid; yellow label.

"BAKELITE"

Description: Phenol-formaldehyde condensation-type plastic.
Toxic Hazard Rating:
  Acute Local: Irritant 1; Inhalation 1
  Acute Systemic: 0
  Chronic Local: Allergen 1
  Chronic Systemic: 0
Disaster Control: Slightly dangerous; when heated to decomposition it emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

BAKING POWDER

Toxic Hazard Rating:
  Acute Local: Irritant 1; Allergen 1
  Acute Systemic: 0
  Chronic Local: Allergen 1
  Chronic Systemic: 0

BALATA

Description: Dried juice of the bully tree, Mimusops balata. Resembles gutta percha.
Toxic Hazard Rating:
  Acute Local: Irritant 1; Allergen 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

BALSAM OF PERU

Synonym: Peruvian balsam.
Description: Dark brown viscid liquid; vanilla odor.
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits smoke (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

BANANA OIL. See Amyl Acetate.

BANANA PEEL OIL

Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

BARBITURATES

Synonyms: Derivatives of barbituric acid, i.e., barbital; barbitone; barbital sodium.
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: Ingestion 2; Inhalation 1
  Chronic Local: Allergen 1
  Chronic Systemic: Ingestion 1
Toxicology: Taken internally in large doses they cause marked depression (sometimes preceded by excitation), prolonged coma and death. Allergic skin reactions may occur from contact (Section 9). May be habit-forming.
Treatment and Antidotes: Induce vomiting or wash out stomach. Keep patient warm. Stimulants and artificial respiration in severe cases. Call a physician.
Fire Hazard: Slight; when heated to decomposition, they emit toxic fumes (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

BARBITURIC ACID

Synonym: Malonylurea.
Description: Crystals or white to yellow-white powder.
Formula: $C_4H_4O_3N_2$
Constants:
  Mol. Wt. 128.1
  M. P. 245°C
  B. P. 260°C (Decomp.)
Toxic Hazard Rating:
  Acute Local: Irritant 3; Allergen 1; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
A corrosive and irritating material. Has no hypnotic properties.
Fire Hazard: Slight; on decomposition it emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

BARIUM

Description: Silver, white, slightly lustrous, somewhat malleable metal.
Formula: Ba
Constants: At. Wt. 137.36
  M. P. 850°C
  B. P. 1140°C
  Density 3.5 @20°C
  Vap. Press. 10 mm @1049°C
Toxicity: See Barium Compounds (Soluble).
Radiation Hazard (Section 5): Artificial isotope Ba^{137}, half-life 2.6 minutes; emits gamma rays of 0.67 mev. The permissible levels are: In body: 90 microcuries. In air: 2×10^{-7} microcurie per milliliter. In water: 1.5×10^{-3} microcurie per milliliter. Ba^{137} exists in both a radioactive and a stable form. The radioactive form occurs in equilibrium with its parent, Cs^{137}. The hazard rating and permissible levels are given for the equilibrium mixture. Hazard Rating, Class II (National Bureau of Standards Handbook No. 42).

Artificial isotope Ba^{140}, half-life, 12.8 days; emits beta particles of 1.0 mev (60%) and 0.47 mev (40%) and many gamma rays between .16-0.54 mev. The permissible levels are: In body: 5 microcuries. In air: 6×10^{-8} microcurie per milliliter. In water: 2×10^{-3} microcurie per milliliter. Ba^{140} exists in equilibrium with its daughter, La^{140}. The permissible levels are given for the equilibrium mixture. Hazard Rating, Class II (National Bureau of Standards Handbook No. 42.
Fire Hazard: Moderate in form of dust when exposed to heat or flame or by chemical reaction (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Handling and Shipping: Sections 5 and 11.

BARIUM ACETATE

Description: White crystals.
Formula: $Ba(C_2H_3O_2)_2 \cdot H_2O$

Constants:
Mol. Wt. 273.46
M. P. $-H_2O$ @150°C
Density 2.19
Toxicity: See Barium Compounds (Soluble).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

BARIUM AMIDE
Description: Gray-white crystals.
Formula: $Ba(NH_2)_2$
Constants:
Mol. Wt. 169.41
M. P. 280°C
Toxicity: See Barium Compounds (Soluble).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

BARIUM AMYL SULFATE
Description: White crystals, fatty feel.
Formula: $Ba(C_5H_{11}SO_4)_2 \cdot H_2O$
Constant:
Mol. Wt. 507.80
Toxicity: See Barium Compounds (Soluble).
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3

BARIUM ANTIMONYL TARTRATE
Description: Crystals.
Formula: $BaSb_2(C_4H_4O_6)_4$
Constant:
Mol. Wt. 973.2
Toxicity: See Antimony Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of antimony.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

BARIUM o-ARSENATE
Description: Black crystals.
Formula: $Ba_3(AsO_4)_2$
Constant:
Mol. Wt. 689.90
Toxicity: Highly toxic. See also Arsenic Compounds and Barium Compounds (Soluble).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of arsenic.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

BARIUM ARSENIDE
Description: Brown crystals.
Formula: Ba_3As_2
Constants:
Mol. Wt. 561.90
Density 4.1 @15°C
Toxicity: Highly toxic. See also Arsenic Compounds and Barium Compounds (Soluble).
Disaster Control: See Arsenic Compounds.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

BARIUM AZIDE
Description: Monoclinic prisms.
Formula: $Ba(N_3)_2$
Constants:
Mol. Wt. 221.41
M. P. $-N_2$ @about 120°C
B. P. Explodes
Density 2.936
Toxicity: See Barium Compounds (Soluble) and Azides.
Explosion Hazard: Moderate, when shocked or exposed to heat.
Disaster Control: Dangerous; shock and heat will explode it.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

BARIUM BENZENE SULFONATE
Description: White nacreous leaflets.
Formula: $Ba(C_6H_5 \cdot SO_3)_2 \cdot H_2O$
Constant:
Mol. Wt. 469.71
Toxicity: See Barium Compounds (Soluble).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Ventilation Control (use normal rate): Section 2

Personal Hygiene: Section 3
Storage and Handling: Section 7

BARIUM BENZOATE
Description: White nacreous leaflets.
Formula: $Ba(C_7H_5O_2)_2 \cdot 2H_2O$
Constants:
  Mol. Wt. 415.61
  M. P. $-2H_2O$ @100°C
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: Slight; on decomposition it emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

BARIUM BINOXALATE
Synonym: Acid barium oxalate.
Description: Crystals.
Formula: $Ba(HC_2O_4)_2 \cdot 2H_2O$
Constant:
  Mol. Wt. 351.45
Toxicity: See Barium Compounds (Soluble) and Oxalates.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

BARIUM BOROWOLFRAMATE
Synonym: Barium borotungstate.
Description: Crystals; rapidly effloresce in air.
Formula: $2BaO \cdot B_2O_3 \cdot 9WO_3 \cdot 18H_2O$
Constant:
  Mol. Wt. 2787.93
Toxicity: See Barium Compounds (Soluble).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

BARIUM BROMATE
Description: White crystals or crystalline powder.
Formula: $Ba(BrO_3)_2 \cdot H_2O$
Constants:
  Mol. Wt. 411.21
  M. P. Decomp. 260°C
  Density 3.99 @18°C
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: Moderate by chemical reaction with easily oxidized materials (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes of bromine; can react with reducing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

BARIUM BROMIDE
Description: Colorless crystals.
Formula: $BaBr_2$
Constants:
  Mol. Wt. 297.19
  M. P. 847°C
  Density 4.781 @24°C
Toxicity: See Barium Compounds (Soluble).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

BARIUM BROMIDE FLUORIDE
Description: Plates.
Formula: $BaBr_2 \cdot BaF_2$
Constants:
  Mol. Wt. 472.55
  Density 4.96 @18°C
Toxicity: See Fluorides and Barium Compounds (Soluble).
Disaster Control: See Bromides and Fluorides.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

BARIUM BROMOPLATINATE
Description: Monoclinic crystals.
Formula: $BaPtBr_6 \cdot 10H_2O$
Constants:
  Mol. Wt. 992.25
  Density 3.71
Toxicity: See Barium Compounds (Soluble).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

BARIUM BUTYRATE
Description: Crystals.
Formula: $Ba(C_4H_7O_2)_2 \cdot 2H_2O$
Constant:
  Mol. Wt. 347.59
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: Slight; on decomposition it emits toxic fumes.
Ventilation Control (use normal rate):

Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

BARIUM CARBIDE
Description: Gray crystals.
Formula: BaC_2
Constants:
Mol. Wt. 161.4
Density 3.75
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: Moderate, by chemical reaction with moisture to form acetylene.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate; it evolves acetylene vapor upon contact with moisture.
Disaster Control: Dangerous; it will react with water or steam to produce flammable vapors.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

BARIUM CARBONATE
Description: White powder.
Formula: $BaCO_3$
Constants:
Mol. Wt. 197.37
M. P. 1740 @ 90 atm.
B. P. Decomposes
Density 4.43
Toxicity: See Barium Compounds (Soluble).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

BARIUM CHLORATE
Description: Colorless prisms or white powder.
Formula: $Ba(ClO_3)_2 \cdot H_2O$
Constants:
Mol. Wt. 322.29
M. P. Anhydrous 414°C
Density 3.18
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: See Chlorates.
Explosion Hazard: See Chlorates.
Disaster Control: See Chlorates.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

BARIUM CHLORATE, WET. See Barium Chlorate.

BARIUM CHLORIDE
Description: Colorless flat crystals.
Formula: $BaCl_2$
Constants:
Mol. Wt. 208.27
M. P. Transition @ 925°C to cubic crystals
B. P. 1560°C
Density 3.856 @ 24°C
Toxicity: See Barium Compounds (Soluble).
Shipping Regulations: Section 11. MAC warning label.

BARIUM CHLOROPLATINATE
Description: Rhombic orange-yellow crystals.
Formula: $BaPtCl_6 \cdot 6H_2O$
Constants: Mol. Wt. 653.43
M. P. $-5H_2O$ @ 70°C
Density 2.868
Toxicity: See Barium Compounds (Soluble).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

BARIUM CHLOROPLATINITE
Description: Crystals.
Formula: $BaPtCl_4 \cdot 3H_2O$
Constants:
Mol. Wt. 528.47
Density 2.868
Toxicity: See Barium Compounds (Soluble).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

BARIUM CHROMATE
Description: Heavy yellow crystalline powder.
Formula: $BaCrO_4$
Constants:
Mol. Wt. 253.37
Density 4.498 @ 15°C
Toxicity: See Barium Compounds (Soluble) and Chromium Compounds.
Fire Hazard: See Chromates.

Disaster Control: Dangerous; reacts vigorously with reducing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

BARIUM CITRATE

Description: White powder.
Formula: $Ba_3(C_6H_5O_7)_2 \cdot 7H_2O$
Constant:
Mol. Wt. 916.39
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: Slight; when heated, it emits smoke (Section 6).
Storage and Handling: Section 7

BARIUM COMPOUNDS (SOLUBLE)

Toxic Hazard Rating:
- Acute Local: Irritant 1; Ingestion 1; Inhalation 1
- Acute Systemic: Ingestion 2; Inhalation 2
- Chronic Local: Irritant 1
- Chronic Systemic: Ingestion 1; Inhalation 1

MAC: ACGIH (accepted): 0.5 milligrams per cubic meter of air.
Toxicology: The soluble barium salts, such as the chloride and sulfide, are poisonous when taken by mouth. The insoluble sulfate used in radiography is nonpoisonous. Few cases of industrial systemic poisoning have been reported, but one investigator describes a fatal case of poisoning attributed to barium oxide, the symptoms being severe abdominal pain with vomiting, dyspnoea, rapid pulse, paralysis of the right arm and leg, and eventually cyanosis and death. The same investigator produced paralysis in animals with barium oxide and carbonate. The usual result of exposure to the sulfide, oxide and carbonate is irritation of the eyes, nose and throat, and of the skin, producing dermatitis (Section 9). The salts mentioned are somewhat caustic.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Label Required: MCA warning label required on Barium Chloride, Barium Fluosilicate and Barium Nitrate.

BARIUM CYANIDE

Description: White crystalline powder.
Formula: $Ba(CN)_2$
Constant:
Mol. Wt. 189.40
Toxicity: Highly toxic. See also Cyanides and Barium Compounds (Soluble).
Storage and Handling: Section 7
Shipping Regulations: Section 11
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

BARIUM CYANOPLATINITE

Description: (a) Monoclinic yellow crystals; (b) rhombic green crystals.
Formula: $BaPt(CN_4) \cdot 4H_2O$
Constants:
Mol. Wt. 508.73
M. P. $-2H_2O$ @100°C
Density (a) 2.076; (b) 2.085
Toxicity: See Barium Compounds (Soluble) and Cyanides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanide.
Storage and Handling: Section 7

BARIUM DICHROMATE

Synonym: Barium bichromate.
Description: Brownish-red crystalline masses.
Formula: $BaCr_2O_7$
Constant:
Mol. Wt. 353.38
Toxicity: See Barium Compounds (Soluble) and Chromium Compounds.
Fire Hazard: Moderate by chemical reaction with easily oxidized materials; can react vigorously with reducing materials (Section 6).
Caution: A powerful oxidizer.
Storage and Handling: Section 7

BARIUM DIPHENYLAMINE SULFONATE

Description: Crystals.
Formula: $Ba(C_6H_5 \cdot NH \cdot C_6H_4SO_3)_2$
Constants:
 Mol. Wt. 633.91
Toxicity: See Barium Compounds (Soluble).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

BARIUM DI-o-PHOSPHATE

Description: Rhombic white crystals.
Formula: $BaHPO_4$
Constants:
 Mol. Wt. 233.35
 Density 4.165 @15°C
Toxicity: See Barium Compounds (Soluble).
Ventilation Control (use moderate rate): Section 2

BARIUM DITHIONATE

Synonym: Barium hyposulfate.
Description: Rhombic or monoclinic colorless crystals.
Formula: $BaS_2O_6 \cdot 2H_2O$
Constants:
 Mol. Wt. 333.52
 M. P. Decomposes
 Density 4.536 @13.5°C
Toxicity: See Barium Compounds (Soluble).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

BARIUM ETHYLSULFATE

Synonym: Barium sulfovinate.
Description: Colorless crystals; white lustrous leaf.
Formula: $Ba(C_2H_5SO_4)_2 \cdot 2H_2O$
Constant:
 Mol. Wt. 423.63
Toxicity: See Barium Compounds (Soluble).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of sulfur.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

BARIUM FERROCYANIDE

Description: Yellow crystals.
Formula: $Ba_2Fe(CN)_6 \cdot 6H_2O$
Constant:
 Mol. Wt. 594.77
Toxicity: See Barium Compounds (Soluble) and Ferrocyanides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

BARIUM FLUOGALLATE

Description: White crystals.
Formula: $Ba_3(GaF_6)_2 \cdot H_2O$
Constants:
 Mol. Wt. 797.54
 M. P. $-\frac{1}{2}H_2O$ @110°C; $-\frac{1}{2}H_2O$ @230°C
 Density 4.06
Toxicity: See Barium Compounds (Soluble) and Fluogallates.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of fluorides.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

BARIUM FLUORIDE

Description: White powder.
Formula: BaF_2
Constants:
 Mol. Wt. 175.36
 M. P. 1280°C
 B. P. 2137°C
 Density 4.83
Toxicity: See Fluorides and Barium Compounds (Soluble).
Disaster Control: See Fluorides.
Storage and Handling: Section 7

BARIUM FLUORIDE CHLORIDE

Description: Tetragonal crystals.
Formula: $BaCl_2 \cdot BaF_2$
Constants:
 Mol. Wt. 383.63

M. P. 1008°C
Density: 4.51 @18°C
Toxicity: See Barium Compounds (Soluble) and Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

BARIUM FLUORIDE IODIDE
Description: Plates.
Formula: $BaF_2 \cdot BaI_2$
Constants:
Mol. Wt. 566.56
Density 5.21 @18°C
Toxicity: See Barium Compounds (Soluble) and Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

BARIUM FLUOSILICATE
Synonym: Barium silicofluoride.
Description: White crystalline powder.
Formula: $BaSiF_6$
Constants:
Mol. Wt. 279.42
Density 4.29 @21°C
Toxicity: See Barium Compounds (Soluble) and Fluosilicates.
Disaster Control: See Fluosilicates.
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

BARIUM FORMATE
Description: Crystals.
Formula: $Ba(COOH)_2$
Constants:
Mol. Wt. 227.40
Density 3.21
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: Slight; when heated, emits acrid fumes.
Storage and Handling: Section 7

BARIUM d-GLUCONATE
Description: Prisms or rhombic leaflets.
Formula: $Ba(C_6H_{11}O_7)_2 \cdot 3H_2O$
Constants:
Mol. Wt. 581.71
M. P. $-3H_2O$ @100°C; 120°C Decomposes
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: Slight; when heated, emits acrid fumes.
Storage and Handling: Section 7

BARIUM HEXABORIDE
Description: Cubic black metallic crystals.
Formula: BaB_6
Constants:
Mol. Wt. 202.28
M. P. 2270°C
Density 4.36 @15°C
Toxicity: See Barium Compounds (Soluble) and Boron.

BARIUM HYDRATE. See Barium Hydroxide.

BARIUM HYDRIDE
Description: Gray crystals or lumps.
Formula: BaH_2
Constants:
Mol. Wt. 139.38
M. P. Decomposes 675°C
B. P. 1400°C
Density 4.21 @0°C
Toxicity: See Barium Compounds (Soluble) and Hydrides.
Fire Hazard: See Hydrides.
Explosion Hazard: See Hydrides.
Disaster Control: See Hydrides.
Storage and Handling: Section 7

BARIUM HYDROGEN PYROTELLURATE
Description: Voluminous precipitate; yellow when hot; white when cold.
Formula: $Ba(HTe_2O_7)_2 \cdot H_2O$
Constant:
Mol. Wt. 891.83
Toxicity: See Barium Compounds (Soluble) and Tellurium Compounds.
Disaster Control: See Tellurium Compounds.
Storage and Handling: Section 7

BARIUM HYDROSULFIDE
Description: Rhombic yellow crystals.
Formula: $Ba(HS)_2 \cdot 4H_2O$
Constants:
Mol. Wt. 275.57
M. P. Decomposes 50°C
Toxicity: See Barium Compounds (Soluble) and Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides
Storage and Handling: Section 7

BARIUM HYDROXIDE
Synonyms: Barium hydrate; caustic baryta.

Description: White powder.
Formula: $Ba(OH)_2 \cdot 8H_2O$
Constants:
 Mol. Wt. 315.51
 M. P. 78°C
 B. P. $-8H_2O$ @780°C
 Density 2.18 @16°C; anhy. 4.50
Toxicity: See Barium Compounds (Soluble).

BARIUM HYPOCHLORITE
Description: Colorless crystals.
Formula: $Ba(ClO)_2 \cdot 2H_2O$
Constants:
 Mol. Wt. 276.31
 M. P. Decomposes
Toxicity: See Barium Compounds (Soluble) and Hypochlorites.
Fire Hazard: See Hypochlorites.
Explosion Hazard: See Hypochlorites.
Disaster Control: See Hypochlorites.
Storage and Handling: Section 7

BARIUM HYPOPHOSPHATE
Description: Needle-like crystals.
Formula: $BaPO_3$
Constant:
 Mol. Wt. 216.34
Toxicity: See Barium Compounds (Soluble).
Disaster Control: See Hypophosphates.
Storage and Handling: Section 7

BARIUM HYPOPHOSPHITE
Description: Crystalline powder.
Formula: $Ba(H_2PO_2)_2 \cdot H_2O$
Constants:
 Mol. Wt. 285.38
 M. P. Decomposes
 Density 2.90 @17°C
Toxicity: See Barium Compounds (Soluble) and Hypophosphites.
Explosion Hazard: See Hypophosphites.
Disaster Control: See Hypophosphites.
Storage and Handling: Section 7

BARIUM IODATE
Description: White crystalline powder.
Formula: $Ba(IO_3)_2$
Constants:
 Mol. Wt. 487.20
 M. P. Decomposes
 Density 4.998
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: See Iodates.
Disaster Control: See Iodates.
Storage and Handling: Section 7

BARIUM IODIDE
Description: Colorless crystals.
Formula: BaI_2
Constants:
 Mol. Wt. 391.19
 M. P. 740°C
 Density 4.917
Toxicity: See Barium Compounds (Soluble).

BARIUM LACTATE
Description: White powder.
Formula: $Ba(CH_3 \cdot CH \cdot OH \cdot COO)_2$
Constant:
 Mol. Wt. 315.50
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: Slight; when heated emits smoke (Section 6).
Storage and Handling: Section 7

BARIUM LAURATE
Description: White, leaflet crystals.
Formula: $Ba(C_{12}H_{23}O_2)_2$
Constants:
 Mol. Wt. 535.97
 M. P. 260°C
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: Slight; when heated, emits acrid fumes.
Storage and Handling: Section 7

BARIUM 1-MALATE
Description: White powder.
Formula: $BaC_4H_4O_5$
Constant:
 Mol. Wt. 269.43
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: Slight; when heated, emits acrid fumes.
Storage and Handling: Section 7

BARIUM MALONATE
Description: White powder.
Formula: $BaC_3H_2O_4 \cdot H_2O$
Constant:
 Mol. Wt. 257.42
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: Slight; when heated it emits acrid fumes.
Storage and Handling: Section 7

BARIUM MANGANATE
Synonyms: Manganese green; cassels green.
Description: Emerald green powder.
Formula: $BaMnO_4$
Constants:
Mol. Wt. 256.29
Density 4.85
Toxicity: See Barium Compounds (Soluble) and Manganese Compounds.
Fire Hazard: Slight, by chemical reaction with reducing agents (Section 6); an oxidizer.
Storage and Handling: Section 7

BARIUM METHYLSULFATE
Description: Efflorescent crystals.
Formula: $Ba(CH_3SO_4)_2 \cdot 2H_2O$
Constant:
Mol. Wt. 395.59
Toxicity: See Barium Compounds (Soluble).
Storage and Handling: Section 7

BARIUM MOLYBDATE
Description: White powder; tetragonal crystals.
Formula: $BaMoO_4$
Constants:
Mol. Wt. 297.31
Density 4.65 - 4.97
Toxicity: See Barium Compounds (Soluble).

BARIUM MONO-HYDROGEN o-ARSENATE
Description: Rhombic or monoclinic colorless crystals.
Formula: $BaHAsO_4 \cdot H_2O$
Constants:
Mol. Wt. 295.29
M. P. $-H_2O$ @150°C
Density 3.93 @15°C
Toxicity: Highly toxic. See Barium Compounds (Soluble) and Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

BARIUM MONO o-PHOSPHATE
Description: Triclinic crystals.
Formula: $BaH_4(PO_4)_2$
Constants:
Mol. Wt. 331.35
Density 2.9 @4°C
Toxicity: See Barium Compounds (Soluble).

BARIUM MONOSULFIDE
Synonym: Barium sulfide.
Description: Cubic colorless crystals.
Formula: BaS
Constants:
Mol. Wt. 169.43
Density 4.25 @15°C
Toxicity: See Barium Compounds (Soluble) and Sulfides.
Fire Hazard: Moderate, by spontaneous chemical reaction; air, moisture or acid fumes may cause it to ignite.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

BARIUM MYRISTATE
Description: White crystalline powder.
Formula: $Ba(C_{14}H_{27}O_2)_2$
Constant:
Mol. Wt. 592.07
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: Slight; when heated, emits acrid fumes.
Storage and Handling: Section 7

BARIUM NITRATE
Synonym: Nitrobarite.
Description: Lustrous white crystals.
Formula: $Ba(NO_3)_2$
Constants:
Mol. Wt. 261.38
M. P. 592°C
B. P. Decomposes
Density 3.24 @23°C
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material.
MCA warning label.

BARIUM NITRIDE
Description: Colorless crystals.
Formula: Ba_3N_2
Constants:
Mol. Wt. 440.10

M. P. 1000°C
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: Moderate, by spontaneous chemical reaction with water to liberate flammable vapor. See also Ammonia.
Explosion Hazard: Slight, by spontaneous chemical reaction to liberate vapor which can form explosive mixtures with air. See also Ammonia.
Disaster Control: See Nitrides.
Storage and Handling: Section 7

BARIUM NITRITE
Description: White crystals.
Formula: $Ba(NO_2)_2$
Constants:
  Mol. Wt. 229.38
  M. P. Decomposes 217°C
  Density 3.23 @ 23°C
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: See Nitrites.
Explosion Hazard: See Nitrites.
Disaster Control: See Nitrites.
Storage and Handling: Section 7

BARIUM OLEATE
Description: Yellowish-white granular masses.
Formula: $Ba(C_{18}H_{33}O_2)_2$
Constant:
  Mol. Wt. 700.25
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: Slight; when heated, emits acrid fumes.
Storage and Handling: Section 7

BARIUM OXALATE
Description: White crystalline powder.
Formula: BaC_2O_4
Constants:
  Mol. Wt. 225.38
  Density 2.658
Toxicity: See Barium Compounds (Soluble) and Oxalates.

BARIUM OXIDE
Synonyms: Barium monoxide; barium protoxide.
Description: White to yellowish-white powder.
Formula: BaO
Constants:
  Mol. Wt. 153.36
  M. P. 1923°C
  B. P. 2000°C (approx.)
  Density 5.72
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: Slight by spontaneous chemical reaction; produces heat on contact with water or steam (Section 6).
Storage and Handling: Section 7

BARIUM PALMITATE
Description: White crystalline powder.
Formula: $Ba(C_{16}H_{31}O_2)_2$
Constants:
  Mol. Wt. 648.19
  M. P. Decomposes
Toxicity: See Barium Compounds (Soluble).

BARIUM PERCHLORATE
Description: Colorless crystals.
Formula: $Ba(ClO_4)_2 \cdot 3H_2O$
Constants:
  Mol. Wt. 390.4
  M. P. Decomp. @ 400°C
  Density 2.74
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: See Perchlorates.
Explosion Hazard: See Perchlorates.
Disaster Control: See Perchlorates.
Storage and Handling: Section 7
Shipping Regulations: Section 11
  I.C.C. Classification: Oxidizing material; yellow label.
  Coast Guard Classification: Oxidizing material; yellow label.

BARIUM PERMANGANATE
Description: Brownish-violet crystals.
Formula: $Ba(MnO_4)_2$
Constant:
  Mol. Wt. 375.22
Toxicity: See Barium Compounds (Soluble) and Manganese Compounds.
Fire Hazard: See Permanganates.
Disaster Control: See Permanganates.
Storage and Handling: Section 7
Shipping Regulations: Section 11
  I.C.C. Classification: Oxidizing material; yellow label.
  Coast Guard Classification: Oxidizing material; yellow label.

BARIUM PEROXIDE

Synonyms: Barium binoxide; barium dioxide.
Description: Grayish-white powder.
Formula: BaO_2
Constants:
Mol. Wt. 169.36
M. P. 450°C
B. P. $-O_2$ @ 800°C
Density 4.96
Toxicity: See Barium Compounds (Soluble) and Peroxides, Inorganic
Fire Hazard: See Peroxides, Inorganic.
Disaster Control: See Peroxides, Inorganic.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

BARIUM PEROXYDISULFATE

Description: Monoclinic white crystals.
Formula: $BaS_2O_8 \cdot 4H_2O$
Constants:
Mol. Wt. 401.57
M. P. Decomposes
Toxicity: See Barium Compounds (Soluble).

BARIUM PHENOLSULFONATE

Synonyms: Barium sulfophenylate; barium sulfocarbolate.
Description: White odorless powder.
Formula: $C_{12}H_{12}BaO_9S_2$
Constants:
Mol. Wt. 501.71
Toxicity: See Barium Compounds (Soluble) and Phenolsulfonates.

BARIUM PHOSPHATE, DIBASIC

Synonym: Secondary barium phosphate.
Description: Crystalline powder.
Formula: $BaHPO_4$
Constant:
Mol. Wt. 233.35
Toxicity: See Barium Compounds (Soluble).
Disaster Control: See Phosphates.

BARIUM PHOSPHITE

Description: Crystalline powder.
Formula: $BaHPO_3$
Constant:
Mol. Wt. 217.35
Toxicity: See Barium Compounds (Soluble).
Disaster Control: See Phosphites.

BARIUM PROPIONATE

Description: White powder.
Formula: $C_6H_{10}BaO_4 \cdot H_2O$
Constants:
Mol. Wt. 301.52
M. P. 300°C Decomposes
Toxicity: See Barium Compounds (Soluble).

BARIUM PYROPHOSPHATE

Description: Rhombic white crystals.
Formula: $Ba_2P_2O_7$
Constants:
Mol. Wt. 448.68
Density 3.9 @ 20°C
Toxicity: See Barium Compounds (Soluble).
Disaster Control: See Phosphates.
Storage and Handling: Section 7

BARIUM PYROVANADATE

Description: White crystals.
Formula: $Ba_2V_2O_7$
Constants:
Mol. Wt. 488.62
M. P. 863°C
Toxicity: See Barium Compounds (Soluble) and Vanadium.

BARIUM RICINOLEATE

Description: Fine white powder.
Formula: $Ba[CO_2(CH_2)_7CHCHCH_2CHOH(CH_2)_5CH_3]_2$
Constants:
Mol. Wt. 727
M. P. 116°C
Density 1.21 @ 25°/25°
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: Slight; when heated it emits acrid fumes.
Storage and Handling: Section 7

BARIUM SALICYLATE

Description: White needles.
Formula: $Ba(C_7H_9O_3)_2 \cdot H_2O$
Constant:
Mol. Wt. 429.60
Toxicity: An allergen. See also Barium Compounds (Soluble).

BARIUM SELENATE

Description: Orthorhombic crystals.
Formula: $BsSeO_4$

Constants:
Mol. Wt. 280.32
M. P. Decomposes
Density 4.75
Toxicity: See Barium Compounds (Soluble) and Selenium Compounds.
Ventilation Control (use normal rate)
Disaster Control: See Selenium Compounds.

BARIUM m-SILICATE
Description: Rhombic, colorless crystals.
Formula: $BaSiO_3$
Constants:
Mol. Wt. 213.42
M. P. 1604 °C
Density 4.399
Toxicity: See Barium Compounds (Soluble).
Ventilation Control (use normal rate): Section 2

BARIUM SILICOFLUORIDE. See Barium Fluosilicate.

BARIUM STEARATE
Description: White powder.
Formula: $Ba(C_{18}H_{35}O_2)_2$
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: Slight; when heated, it emits acrid fumes.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

BARIUM SUCCINATE
Description: Crystalline powder.
Formula: $BaC_4H_4O_4$
Constants:
Mol. Wt. 253.43
Toxicity: See Barium Compounds (Soluble).
Fire Hazard: Slight; when heated it emits acrid fumes.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

BARIUM SULFHYDRATE
Description: Yellow crystals.
Formula: $Ba(SH)_2$
Constant:
Mol. Wt. 203.51
Toxicity: See Barium Compounds (Soluble) and Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

BARIUM SULFIDE. See Barium Monosulfide.

BARIUM SULFITE
Description: White powder.
Formula: $BsSO_3$
Constants:
Mol. Wt. 217.42
Toxicity: See Barium Compounds (Soluble) and Sulfites.
Disaster Control: See Sulfites.
Storage and Handling: Section 7

BARIUM SULFOCYANATE
Synonym: Barium sulfocyanide.
Description: White crystals.
Formula: $Ba(SCN)_2 \cdot 2H_2O$
Constant:
Mol. Wt. 289.55
Toxicity: Highly toxic. See also Barium Compounds (Soluble) and Thiocyanates.
Disaster Control: See Sulfocyanates.
Ventilation Control (use normal rate): Section 2

BARIUM TARTRATE
Description: White granular powder.
Formula: $BaC_4H_4O_6 \cdot H_2O$
Constants:
Mol. Wt. 303.45
Density 2.980 @ 20.8 °C
Toxicity: See Barium Compounds (Soluble).
Storage and Handling: Section 7

BARIUM TELLURATE
Description: White crystals.
Formula: $BaTeO_4 \cdot 3H_2O$
Constants:
Mol. Wt. 383.02
M. P. d. > 200 °C
Density 4.2
Toxicity: See Barium Compounds (Soluble) and Tellurium Compounds
Disaster Control: See Tellurium Compounds.
Storage and Handling: Section 7

BARIUM TETRASULFIDE
Description: Rhombic red or yellow crystals or powder.
Formula: BaS_4
Constants:
Mol. Wt. 265.63
M. P. Decomposes 200 °C
Density 2.988
Toxicity: See Barium Compounds

and Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazards: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

BARIUM THIOCYANATE. See Barium Sulfocyanate.

BARIUM THIOSULFATE
Synonym: Barium hyposulfite.
Description: Crystalline powder.
Formula: BaS_2O_3
Constants: Mol. Wt. 249.49
M. P. Decomposes
Toxicity: See Barium Compounds (Soluble).
Storage and Handling: Section 7

BARIUM o-TRIPHOSPHATE
Description: Cubic white crystals.
Formula: $Ba_3(PO_4)_2$
Constants:
Mol. Wt. 602.04
Density 4.1 @ 16°C
Toxicity: See Barium Compounds (Soluble).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

BARIUM TRISULFIDE
Description: Yellow green crystals.
Formula: BaS_3
Constant: Mol. Wt. 233.54
Toxicity: See Barium Compounds (Soluble) and Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

BARIUM TUNGSTATE
Description: Tetragonal, colorless crystals.
Formula: $BaWO_4$
Constants: Mol. Wt. 385.28
Density 5.04
Toxicity: See Barium Compounds (Soluble).
Ventilation Control (use normal rate): Section 2

BARIUM m-TUNGSTATE
Description: Rhombic crystals.
Formula: $Ba_3(H_2W_{12}O_{40}) \cdot 27H_2O$
Constants; Mol. Wt. 3747.57
Density 4.30
Toxicity: See Barium Compounds (Soluble).
Ventilation Control (use normal rate): Section 2

BARLEY OIL
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; when heated, emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

BASIC COPPER ZEOLITES
Toxicity: See Copper Compounds.

BATTERIES, ELECTRIC STORAGE, WET
Description: Battery electrolytes which contain either sulfuric acid or sodium hydroxide.
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive-liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

BATTERIES, ELECTRIC STORAGE, WET, WITH AUTOMOBILES OR AUTO PARTS. See Sulfuric Acid and/or Sodium Hydroxide, whichever electrolyte is present.
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

BATTERIES, ELECTRIC STORAGE, WET, WITH CONTAINERS OF CORROSIVE BATTERY FLUID. See Sulfur Acid and/or Sodium Hydroxide, whichever electrolyte is present.
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

BATTERY ACID. See Sulfuric Acid.

BATTERY CHARGER WITH ELECTROLYTE (ACID) OR ALKALINE CORROSIVE LIQUID. See Sulfuric Acid and/or Sodium Hydroxide, whichever is present.
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid; white label.

Coast Guard Classification: Corrosive liquid; white label.

BAUXITE. See Aluminum Oxide.

BAYBERRY OIL
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight; when heated, emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

B BLASTING POWDER. See Explosives, Low.

BEEF FAT OIL
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight; when heated, emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

BEESWAX
Synonym: Yellow beeswax.
Description: Yellow to brownish-yellow, soft to brittle wax.
Constants:
  M. P. 62 - 65°C
  Density 0.95 - 0.96
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight; when heated, it burns and emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

"BEETLE"
Description: Urea-formaldehyde condensation product.
Toxic Hazard Rating:
  Acute Local: Allergen 1; Inhalation 1
  Acute Systemic: 0
  Chronic Local: Irritant 1; Allergen 1; Inhalation 1
  Chronic Systemic: U
Caution: Inhalation of dust may cause allergic response or irritation of lungs (Section 9).
Fire Hazard: Slight; when heated to decomposition it emits toxic fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

BELLADONNA
Synonym: Deadly nightshade, from which the alkaloids, atropine and belladonine are derived.
Toxic Hazard Rating:
  Acute Local: 0
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: 0
  Chronic Systemic: Ingestion 2; Inhalation 2
Toxicology: A poison. See also Hyoscyamine and Atropine. Local contact may cause a contact dermatitis (Section 9).
Fire Hazard: Slight; when heated, it emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

BENZAL CHLORIDE
Synonyms: Benzyl dichloride; benzylidine chloride.
Description: Very refractive liquid.
Formula: $C_6H_5CHCl_2$
Constants:
  Mol. Wt. 161.03
  M. P. −16°C
  B. P. 214°C
  Density 1.29
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1; Inhalation 1
  Acute Systemic: Ingestion 1; Inhalation 1
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

BENZALDEHYDE

Synonyms: Benzoic aldehyde; artificial almond oil.
Description: Refractive liquid.
Formula: C_6H_5CHO
Constants:
  Mol. Wt. 106.12
  M. P. -26°C
  B. P. 179.0°C
  Flash P. 298.4°F (C.C.)
  Density 1.050 @15°/4°C
  Autoign. Temp. 377°F
  Vap. Press. 1 mm @26.2°C
  Vap. D. 3.65
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: Skin Absorption 1
  Chronic Local: Allergen 1
  Chronic Systemic: U
Caution: Acts as a feeble local anesthetic. See Aldehydes. Local contact may cause contact dermatitis (Section 9).
Fire Hazard: Slight, when exposed to heat or flame; reacts with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

BENZALDEHYDE CYANHYDRIN

Synonym: Mandelonitrile.
Description: Yellow viscous liquid.
Formula: $C_6H_5CH(OH)CN$
Constants:
  Mol. Wt. 133.14
  M. P. -10°C
  B. P. 170°C Decomposes
  Density 1.124
Toxicity: Details unknown, but probably highly toxic. See also Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

BENZALMALONONITRILE

Description: Crystals.
Formula: $C_6H_5CH_2CH(CN)_2$
Constant:
  Mol. Wt. 156.2
Toxicity: See Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

BENZANTHRONE

Description: Pale yellow needles.
Formula: $C_{17}H_{10}O$
Constants:
  Mol. Wt. 230.25
  M. P. 174°C
  Vap. Press. 1 mm @225.0°C
Toxicity: Unknown.
Fire Hazard: Slight; when heated, emits smoke (Section 6).
Storage and Handling: Section 7

"BENZEDRINE"

Synonym: Amphetamine.
Description: Liquid.
Formula: $C_9H_{13}N$
Constants:
  Mol. Wt. 135.20
  B. P. 200°C
  Flash P. 80°F (O.C.)
  Density 0.931
  Vap. D. 4.65
Toxic Hazard Rating:
  Acute Local: 0
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: 0
  Chronic Systemic: Ingestion 1; Inhalation 1
Caution: A stimulant. Overdoses cause hyperactivity, restlessness, insomnia, rapid pulse, rise in blood pressure, dilated pupils, dryness of the throat.
Treatment and Antidotes: Evacuation of stomach if taken by mouth, sedatives. Call a physician.
Fire Hazard: Dangerous; when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide or dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous, upon exposure to heat or flame.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

BENZENE

Synonyms: Benzol; phenyl hydride; coal naphtha.
Description: Clear colorless liquid.
Formula: C_6H_6
Constants:
  Mol. Wt. 78.11
  M. P. 5.51°C
  B. P. 80.093° - 80.094°C
  Flash P. 12°F (C.C.)
  Density 0.8794 @20°C

Autoign. Temp. 1000°F
Vap. Press. 100 mm @26.1°C
Vap. D. 2.77

Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 1; Inhalation 1
Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Chronic Local: 0
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3

MAC: ACGIH (accepted); 35 parts per million in air; 112 milligrams per cubic meter of air.

Toxicology: Poisoning occurs most commonly through inhalation of the vapor, though benzene can penetrate the skin, and thus contribute to the poisoning.

Locally, benzene has a comparatively strong irritating effect, producing erythema and burning, and in more severe cases, edema and even blistering (Section 9). Exposure to high concentrations of the vapor (3,000 ppm or higher) results from accidents such as failure of equipment or spillage. Such exposure, while rare in industry, may result in acute poisoning, characterized by the narcotic action of benzene on the central nervous system. The anesthetic action of benzene is similar to that of other anesthetic gases, consisting of a preliminary stage of excitation followed by depression and, if exposure is continued, death through respiratory failure.

The chronic, rather than the acute form of benzene poisoning is important in industry; it is a toxic action on the blood-forming tissues. There is no specific blood picture occurring in cases of chronic benzol poisoning.

The bone marrow may be hypoplastic, normal, or hyperplastic, the changes being reflected in the peripheral blood. Anemia, leucopenia, macrocytosis, reticulocytosis, thrombocytopenia, high color index, and prolonged bleeding time may not be present. For the supervision of the worker, repeated blood examinations are necessary, including hemoglobin determinations, white and red cell counts and differential smears. Where a worker shows a progressive drop in either red or white cells, or where the white count remains below 5,000 per cu. mm., or the red count below 4.0 million per cu. mm., on two successive monthly examinations, he should be immediately removed from exposure. With this method of supervision of the worker, no permanent damage will result to the blood-forming system.

Following absorption of benzene, elimination is chiefly through the lungs, when fresh air is breathed. The portion that is absorbed, is oxidized, and the oxidation products are combined with sulfuric and glycuronic acids and eliminated in the urine. This may be used as a diagnostic sign. Benzene has a definite cumulative action, and exposure to relatively high concentrations are not serious from the point of view of causing damage to the blood-forming system, provided that the exposure is not repeated. On the other hand, daily exposure to concentrations of 100 ppm or less will usually cause damage if continued over a protracted period of time.

In acute poisoning, the worker becomes confused and dizzy, complains of tightening of the leg muscles and of pressure over the forehead, then passes into a stage of excitement. If allowed to remain in exposure, he quickly becomes stupefied and lapses into coma. In nonfatal cases, recovery is usually complete and no permanent disability occurs.

In chronic poisoning the onset is slow, with the symptoms vague; fatigue, headache, dizziness, nausea and loss of appetite, loss of weight, and weakness are common complaints in early cases. Later, pallor, nose-bleeds, bleeding gums, menorrhagia, petechiae and purpura may develop. There is great individual variation in the signs and symptoms of chronic benzene poisoning.

Fire Hazard: Dangerous; when exposed to heat or flame; can react vigorously with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetra-chloride (Section 6).
Explosion Hazard: Moderate, when its vapors are exposed to flame. Use with adequate ventilation.
Explosive Range: 1.4 - 8.0%
Disaster Control: Dangerous; when heated it burns vigorously and emits acrid fumes.
Ventilation Control (use high rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Inflammable liquid; red label.
  MCA warning label.

m-BENZENEDISULFONIC ACID

Synonym: MBDSA
Description: Grey crystalline hygroscopic powder.
Formula: $C_6H_6O_6S_2$
Constant:
  Mol. Wt. 238.23
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 2
  Acute Systemic: U
  Chronic Local: Irritant 2
  Chronic Systemic: U
Caution: In solutions it forms an extremely corrosive liquid.
Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes of oxides of sulfur.
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

BENZENE HEXACHLORIDE

Synonyms: Gammahexane; lindane; hexachlorocyclohexane.
Description: White crystalline powder.
Formula: $C_6H_6Cl_6$
Constants:
  Mol. Wt. 290.84
  M. P. 157°C
  Vap. Press. 0.0317 mm @20°C
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: Ingestion 3; Inhalation 2
  Chronic Local: Allergen 2
  Chronic Systemic: Ingestion 2; Inhalation 2
MAC: ACGIH (tentative); 0.5 milligram per cubic meter of air.

Toxicology: Benzene hexachloride, a local irritant, may be absorbed through the skin. The several isomers of benzene hexachloride have different actions. The gamma and alpha isomers are central nervous system stimulants, the principal symptom being convulsions. The beta and delta isomers are depressants of the central nervous system.

The dangerous acute dose of the technical mixture has been estimated at about 30 g, and the dangerous dose of lindance at about 7 to 15 g. These estimates may be too high. For a young man suffered a serious illness, including convulsions, following a single carefully measured dose of 45 mg intended as a vermifuge. It is true that, in similar studies of the potential use of benzene hexachloride as a drug, other persons have withstood larger doses, especially of undissolved material, apparently without injurious effect. Thus 40 mg of a purified commercial preparation was tolerated daily for 10 days. This mixture of isomers burned the tongue, and unpurified mixtures were found to be very irritating. Doses of 70 mg of the preparation caused attacks of dizziness, slight nausea, headache, and a sensation of pressure in the temples. No change was indicated in the blood or urine. Preparations with more than 25 percent gamma isomer were slightly less toxic. Forty mg of pure gamma isomer were given for 14 days with no bodily disturbance. A daily dose of 180 mg caused diarrhea and a feeling of dizziness. A dose of 30 mg three times a day for a week caused no injurious signs in the patient, and no change in the urine or blood. However, as already mentioned, a single dose of 45 mg (or approximately 0.65 mg/kg) of lindane cause convulsions.

It is interesting to note that lindane shows a marked difference in toxicity to different species. Its toxic effect on laboratory animals compares favorably with that of DDT, but for several domestic animals, notably calves, lindane is more toxic than DDT or dieldrin.

Four children drank undetermined amounts of a home-made soft drink containing lindane, which had been mixed with sugar. Within less than 6 hours three vomited and had convulsions. The fourth did likewise within about 12 hours. All recovered without treatment. It was not possible to determine the dosage of lindane.

The fatal poisoning of a 5-year old girl weighing about 55 pounds was caused by the accidental ingestion of 4.5 g of benzene hexachloride as a 30 percent solution in an unspecified organic solvent. This represents a dosage of 180 mg kg. Shortly afterward, she developed dyspnea, cyanosis, and clonic-tonic convulsions. In spite of evacuation of her stomach and therapy to restore failing circulation, she died. Autopsy showed pulmonary edema, dilation of the heart, fatty infiltration of the liver, and extensive necrosis of blood vessels in the lungs, kidney and liver.

The use of thermal vaporizers with lindane has caused some clear-cut instances of acute poisoning. For example, two refreshment-stand operators suffered severe headache, nausea, and irritation of of eyes, nose, and throat shortly after exposure to lindane vapors from a dispenser in which the insecticide apparently became overheated. The symptoms abated 2 hours after the device was removed. Overheated lindane is more apt to cause respiratory distress than lindane which is vaporized at lower temperatures. This is true because heat releases more of the compound and also causes some splitting of the moleucle into highly irritating decomposition products.

Nothing is known of chronic systemic benzene hexachloride poisoning from the study of human subjects. In laboratory animals the gamma isomer has by far the greatest acute toxicity, but its relatively rapid excretion by the kidneys does not permit extensive accumulation in the body and the gamma isomer shows the lowest toxicity on repeated exposure. The highest chronic toxicity and the lowest acute toxicity are shown by the beta isomer. This has no insecticidal importance but forms a part of those formulations prepared from technical grade BHC. The use of lindane is therefore favored not only because it is the most effective form of benzene hexachloride for killing insects, but also because it probably presents a relatively low chronic toxicity to workers.

Dermatitis, and perhaps other manifestations based on sensitivity represent a sort of chronic, though probably not systemic intoxication, which has been observed in human beings. Dermatitis has been reported in workers who came in contact with benzene hexachloride and its precursors during manufacture and without proper hygienic precautions. Shortly after a lindane vaporizer was installed in her place of employment, a 35-year-old woman developed urticaria. The dermatitis improved during weekends, but recurred when she returned to work. Patch tests were positive. Complete elimination of exposure resulted in permanent recovery (Section 9).

The signs and symptoms of confirmed acute poisoning in man have paralled those of experimental animals. These signs and symptoms are: excitation, hyperirritability, loss of equilibrium, clonic-tonic convulsions, and later depression. There is some evidence that the pulmonary edema and vascular collapse may be of neurogenic origin also. The symptoms in animals systemically poisoned by the gamma isomer alone are essentially similar to those caused by mixtures, although the onset may be earlier. Men acutely exposed to high air concentrations of lindane and its decomposition products show headache, nausea, and irritation of eyes, nose and throat.

Urticaria has followed exposure to lindane vapor in rare instances. Unlike the signs and symptoms already mentioned, this allergic manifestation occurs only in susceptible individuals, and usually only after a period of sensitization.

Laboratory findings are essentially normal. Insecticide may be demonstrated in the tissue of the poisoned animal by the use of bioassay or by a specific chemical test.

Pathology in animals from both acute and chronic poisoning is quite similar to that seen in DDT poisoning (See DDT).

Treatment is essentially the same as that for DDT. Wash contaminated skin thoroughly with soap and water. If the poison has been taken internally, clear the alimentary tract with pentobarbital or with phenobarbital. These drugs should be given in large doses and pushed to the limit of therapeutic effectiveness. It is not desirable to depress the patient to the point of hypnosis. However, persons poisoned by stimulants may tolerate large doses of barbiturates without undue depression and with great benefit. Intravenous calcium gluconate has been reported to have some effectiveness as an antidote and may be used in conjunction with the barbiturates.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
MCA warning label.

BENZENE PHOSPHONIC ACID

Description: Colorless crystals.
Formula: $C_6H_5PO(OH)_2$
Constants:
  Mol. Wt. 158.1
  M. P. 165°C
  Density 1.475
Toxicity: Unknown
Storage and Handling: Section 7

BENZENE PHOSPHORUS DICHLORIDE

Synonym: Phenyl dichlorophosphine.
Description: Colorless liquid while in air.
Formula: $C_6H_5PCl_2$
Constants:
  Mol. Wt. 179
  M. P. −55°C
  B. P. 224.6°C
  Density 1.319 @ 20°/20°C
  Vap. D. 6.2
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: See Hydrochloric Acid.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

BENZENE PHOSPHORUS OXYDICHLORIDE

Synonym: Phenyl dichlorophosphine oxide.
Description: Colorless liquid; faint fruity odor.
Formula: $C_6H_5POCl_2$
Constants:
  Mol. Wt. 195
  B. P. 258°C
  Density 1.375 @ 20°/20°C
  Vap. D. 6.7
Toxicity: Unknown
Disaster Control: See Chlorides
Storage and Handling: Section 7

BENZENE PHOSPHORUS THIODICHLORIDE

Synonym: Phenyl dichlorophosphine sulfide.
Description: A colorless liquid which fumes a little in air.
Formula: $C_6H_5PSCl_2$
Constants:
  Mol. Wt. 211
  B. P. 205°C @130 mm
  Density 1.376 @20°/13°C
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, emits highly toxic fumes of chlorides and oxides of phosphorous and sulfur; will react with water or steam to produce toxic and flammable vapors.
Storage and Handling: Section 7

o-BENZENE SULFENYL CHLORIDE

Description: Yellow crystals.
Formula: $O_2NC_6H_4SCl$
Constants:
  Mol. Wt. 189.6
  B. P. Decomposes at 170°C (explosively)
  M. P. 73 - 74°C
Toxicity: Unknown
Explosion Hazard: Moderate, when heated.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of sulfur and chlorides; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

BENZENE SULFONIC ACID

Description: Deliquescent plates or tablets.
Formula: $C_6H_5SO_3H : 1\frac{1}{2}H_2O$
Constants:
  Mol. Wt. 185.2
  M. P. 43 - 44°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: See Sulfur Compounds.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

BENZENE SULFONYL FLUORIDE

Description: Clear liquid.
Formula: $C_6H_5SO_2F$
Constants:
  Mol. Wt. 160
  B. P. 209°C
  Freezing P. -5°C
  Flash P. 196°F
  Density 1.329
  Vap. Press. 8 mm @80°C
  Vap. D. 5.52
Toxicity: It appears to be highly toxic by vapor inhalation. Possibly slightly irritating to skin (Section 9).
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides, chlorides and oxides of sulfur; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

1,2,4,5-BENZENE TETRACARBOXYLIC ACID. See Pyromellitic Acid.

BENZHYDROL

Synonyms: Benzohydrol; diphenyl carbinol.
Description: Needle-like crystals.
Formula: $(C_6H_5)_2CHOH$
Constants:
  Mol. Wt. 184.2
  M. P. 68 - 69°C
  B. P. 301.0°C @50 mm
  Vap. Press. 1 mm @110.0°C
Toxicity: Details unknown; an insecticide.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

BENZIDINE

Synonyms: Benzidine base; p-diaminodiphenyl.
Description: Grayish, yellow crystalline powder; white or slightly reddish crystals, powders or leaf.

Formula: $NH_2C_6H_4C_6H_4NH_2$
Constants:
Mol. Wt. 184.23
M. P. 127.5 - 128.7°C @740 mm
B. P. 401.7°C
Density 1.250 @20°/4°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: On proof.
Chronic Systemic: Ingestion 3; Inhalation 3

Toxicology: Benzidine is of little importance as a methemoglobin former and therefore of a low order of toxicity in industrial exposures. However, it remains on the list of suspected materials because it is a possible cause of bladder tumors, although available data indicate that bladder tumors cannot be caused by the administration of this compound to experimental animals as in the case of beta-naphthylamine. Nevertheless, some authorities still state that benzidine is certainly one of the causes of bladder cancer.

Treatment and Antidotes: In case of contact, immediately wash skin with plenty of soap and water and flush eyes with plenty of water for at least 15 minutes. Secure medical attention at once.

Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes.

Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

BENZIL

Synonym: Dibenzoyl.
Description: Yellow crystals.
Formula: $C_6H_5COCOC_6H_5$
Constants:
Mol. Wt. 210.2
M. P. 95°C
B. P. 346 - 348°C
Density 1.23 @15°/4°C
Vap. Press. 1 mm @128.4°C
Toxicity: Details unknown; an insecticide.
Fire Hazard: Slight; when heated, emits acrid fumes.
Storage and Handling: Section 7

BENZILIC ACID

Synonym: Diphenylglycolic acid.
Description: Light tan powder.
Formula: $C_6H_5C(OH)(COOH)C_6H_5$
Constants:
Mol. Wt. 228.24
M. P. 146 - 149°C
B. P. 180°C Decomposes
Toxicity: Unknown
Fire Hazard: Slight; when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

BENZINE

(Note: This name is not chemically accurate and its use should be avoided.)

Synonyms: Petroleum ether; petroleum benzine.
Description: Clear, colorless, volatile mixture of several of the lighter constituents of petroleum.
Formula: C_nH_{2n+2}
Constants:
M. P. > -100°F
B. P. 38 - 71°C
Flash P. < 0°F (O.C.)
Density 0.64
Autoign. Temp. 475°F
Vap. D. 4.5
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1
Acute Systemic: Ingestion 1; Inhalation 1
Chronic Local: Irritant 1
Chronic Systemic: 0

Caution: May contain some benzene or benzene homologs; an insecticide and solvent. Should not be confused with Benzene.

Fire Hazard: Dangerous; when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when its vapors are exposed to flame. Use with adequate ventilation.
Explosive Range: 1.1 - 4.8%
Disaster Control: Highly dangerous, upon exposure to heat or flame.

Ventilation Control (use high rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Inflammable liquid; red label.

BENZINOFORM, See Carbon Tetrachloride.

BENZOATE OF SODA, See Sodium Benzoate.

BENZOCAINE
Synonym: Ethyl-p-aminobenzoate.
Description: White, crystalline, odorless, tasteless, powder.
Formula: $C_6H_4NH_2COOC_2H_5$
Constants:
  Mol. Wt. 165.19
  M. P. 88 - 90°C
Toxic Hazard Rating:
  Acute Local: Allergen 1; Ingestion 1
  Acute Systemic: Inhalation 1
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight; on decomposition it emits toxic fumes.
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

BENZOGUANAMINE
Description: Crystals.
Formula: $C_6H_5(C_3N_3)(NH_2)_2$
Constants:
  Mol. Wt. 187.2
  M. P. 227°C
  Density 1.4
Toxicity: Unknown
Fire Hazard: Slight; on decomposition it emits toxic fumes.
Storage and Handling: Section 7

BENZOIC ACID
Synonym: Phenylformic Acid.
Description: White powder.
Formula: C_6H_5COOH
Constants:
  Mol. Wt. 122.12
  M. P. 121.7°C
  B. P. 249°C
  Flash P. 250°F (C.C.)
  Density 1.316
  Autoign. Temp. 1065°F
  Vap. Press. 1 mm @96.0°C (sublimes)
  Vap. D. 4.21
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1; Inhalation 1
  Acute Systemic: Ingestion 1
  Chronic Local: 0
  Chronic Systemic: Ingestion 1
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

BENZOIC ANHYDRIDE
Synonym: Benzoic acid anhydride.
Description: Crystals.
Formula: $(C_6H_5CO)_2O$
Constants:
  Mol. Wt. 226.2
  M. P. 42°C
  B. P. 360°C
  Density 1.1989 @15°/4°C
  Vap. Press. 1 mm @143.8°C
Toxic Hazard Rating:
  Acute Local: Irritant 1; Allergen 1; Ingestion 1; Inhalation 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits smoke; will react with water or steam to produce heat (Section 6).
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

BENZOIN
Synonyms: Phenyl alpha-hydroxybenzyl ketone; phenylbenzoyl carbinol.
Description: Pale yellow crystals.
Formula: $C_{14}H_{12}O_2$
Constants:
  Mol. Wt. 212.24
  M. P. 132°C
  B. P. 343°C

Density 1.310 @20°/4°C
Vap. Press. 1 mm @135.6°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1; Ingestion 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes.
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

BENZOL, See Benzene
Shipping Regulations: Section 11
I.C.C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

BENZONITRILE
Synonym: Phenyl cyanide.
Description: Transparent, colorless oil; almond-like odor.
Formula: C_6H_5CN
Constants:
Mol. Wt. 103.12
M. P. −12.9°C
B. P. 190.7°C
Density 1.0102 @15°/15°C
Vap. Press. 1 mm @28.2°C
Flash P. None Discernible
Toxicity: High. See Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

BENZOPHENONE
Synonyms: Phenyl ketone; diphenyl ketone.
Description: Rhombic white crystals; persistent rose-like odor.
Formula: $C_6H_5COC_6H_5$
Constants:
Mol. Wt. 182.21
M. P. α = 49°C; β = 26°C; γ = 47°C
B. P. 305.4°C
Density α form = 1.0976 @ 50°/50°C; β form = 1.108 @ 23°/4°C
Vap. Press. 1 mm @108.2°C
Toxicity: Details unknown. See also Ketones.
Fire Hazard: Slight; when heated, emits smoke; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

BENZOQUINONE
Synonym: Quinone.
Description: Yellow crystals.
Formula: $CO(CHCH)_2CO$
Constants:
Mol. Wt. 108.09
M. P. 115.7°C
B. P. Sublimes
Density 1.307
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 2
Acute Systemic: Ingestion 2
Chronic Local: Allergen 2
Chronic Systemic: Ingestion 2; Inhalation 2
Caution: Injurious to eyes.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-BENZOTHIAZYL DISULFIDE
Description: Cream to light yellow powder.
Formula: $(C_6H_4SNCS)_2$
Constants:
Mol. Wt. 332.5
M. P. 175°C
Density 1.5
Toxicity: Unknown
Disaster Control: See Sulfur Compounds.
Storage and Handling: Section 7

1,2,3-BENZOTRIAZOLE
Synonym: Aziminobenzene.
Description: Needle-like crystals.
Formula: $\underline{C_6H_4NHNN}$
Constants:
Mol. Wt. 119.1
M. P. 100°C
B. P. 204°C @15 mm
Toxicity: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, emits toxic fumes.
Storage and Handling: Section 7

BENZOTRICHLORIDE
Synonym: Toluene trichloride
Description: Clear, colorless to yellowish liquid; penetrating odor.
Formula: $C_6H_5CCl_3$
Constants:
Mol. Wt. 195.46
M. P. −5°C
B. P. 220°C

Density 1.38 @15.5°/15.5°C
Vap. D. 6.77
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: See Hydrochloric Acid.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

BENZOTRIFLUORIDE

Synonym: Trifluoromethylbenzene.
Description: Water-white liquid; aromatic ordor.
Formula: $C_6H_5CF_3$
Constants:
Mol. Wt. 146.1
M. P. −28.5°C
B. P. 101°C
Flash P. 54°F (C.C.)
Density 1.197 @15.5°/15.5°C
Vap. D. 5.04
Toxicity: Unknown
Fire Hazard: Dangerous; when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides; it can react vigorously with oxidizing materials.
Storage and Handling: Section 7

β-BENZOYL ACRYLIC ACID

Synonym: trans-β-Benzoyl acrylic acid.
Description: Straw-yellow crystals.
Formula: $C_6H_5COCHCHCOOH$
Constants:
Mol. Wt. 176.2
M. P. 99°C
Toxicity: Unknown
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

BENZOYL AMINO METHOXY CHLOR ANTHRAQUINONE

Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

BENZOYL CHLORIDE

Synonym: Benzene carbonyl chloride.
Description: Colorless, fuming, pungent liquid.
Formula: C_6H_5COCl
Constants:
Mol. Wt. 140.5
M. P. −0.5°C
B. P. 197°C
Flash P. 215°F (C.C.)
Density 1.2187 @15°/15°C
Vap. Press. 1 mm @32.1°C
Vap. D. 4.88
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: Irritant 1
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene; will react with water or steam to produce heat and toxic and corrosive fumes; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.
MCA warning label.

BENZOYL PEROXIDE, DRY

Description: White, granular, tasteless, odorless crystalline solid.
Formula: $(C_6H_5CO)_2O_2$

Constants:
  Mol. Wt. 242.22
  M. P. 108°C (decomp.)
  B. P. Decomposes explosively
  Autoign. Temp. 176°F
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: Irritant 2
  Chronic Systemic: U
Fire Hazard: Moderate, by spontaneous chemical reaction in contact with reducing agents; will react with water or steam to produce heat; a powerful oxidizer.
To Fight Fire: Carbon dioxide, dry chemical, carbon tetrachloride (Section 6).
Explosion Hazard: Moderate when exposed to heat; has been known to explode spontaneously.
Disaster Control: Dangerous; may explode spontaneously. Must be kept dry. See note under "Benzoyl Peroxide, Wet."
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Oxidizing material; yellow label.
  Coast Guard Classification: Oxidizing material; yellow label.

BENZOYL PEROXIDE, WET

Description: A paste.
Constant:
  Autoign. Temp. 176°F
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: Irritant 2
  Chronic Systemic: U
Fire Hazard: Moderate by chemical reaction with reducing agents; a powerful oxidizer.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; it can react with reducing materials.
Note: Mixed with a large surplus of water (i.e., 30%) this material is relatively safe. It is most dangerous when it contains very low percentages of water (1% or less).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  With not less than 30% water.
  Coast Guard Classification: Inflammable solid; yellow label.

BENZYL ACETATE

Description: Liquid.
Formula: $CH_3COOCH_2C_6H_5$
Constants:
  Mol. Wt. 150.17
  M. P. −51.5°C
  B. P. 213.5°C
  Flash P. 216°F (C.C.)
  Density 1.06
  Autoign Temp. 862°F
  Vap. Press. 1 mm @45.0°C
  Vap. D. 5.1
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: Irritant 1
  Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

BENZYL ALCOHOL

Synonyms: Hydroxytoluene; phenyl carbinol.
Description: Water-white liquid; faint aromatic odor.
Formula: $C_6H_5CH_2OH$
Constants:
  Mol. Wt. 108.13
  M. P. −15.3°C
  B. P. 205.7°C
  Flash P. 213°F (C.C.)
  Density 1.050 @15°/15°C
  Autoign. Temp. 817°F
  Vap. Press. 1 mm @58.0°C
  Vap. D. 3.72

Toxic Hazard Rating:
  Acute Local: Irritant 1; Allergen 1; Ingestion 1; Inhalation 1
  Acute Systemic: Ingestion 1; Inhalation 1; Skin Absorption
  Chronic Local: Irritant 1; Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

BENZYL BENZOATE

Description: Liquid.
Formula: $C_6H_5COOCH_2C_6H_5$
Constants:
  Mol. Wt. 212.2
  M. P. 21°C
  B. P. 324°C
  Flash P. 298°F (C.C.)
  Density 1.114
  Vap. D. 7.3
Toxic Hazard Rating:
  Acute Local: Allergen 1; Ingestion 1; Inhalation 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

BENZYL BROMIDE

Synonym: Bromotoluene.
Description: Clear refractive liquid; pleasant odor.
Formula: $C_6H_5CH_2Br$
Constants:
  Mol. Wt. 171.04
  M. P. -4.0°C
  B. P. 198°C
  Density 1.438 @22°/0°C
  Vap. D. 5.8
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes of bromides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Corrosive liquid; white label.
  Coast Guard Classification: Corrosive liquid; white label.

BENZYL "CELLOSOLVE"

Synonym: Ethylene glycol mono benzyl ether.
Description: Water-white liquid; faint rose-like odor.
Formula: $C_6H_5CH_2OCH_2CH_2OH$
Constants:
  Mol. Wt. 152.19
  M. P. -75°C
  B. P. 256°C
  Flash P. 265°F (O.C.)
  Density 1.068
  Autoign Temp. 665°F
  Vap. D. 5.25
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 2; Inhalation 1
  Acute Systemic: Ingestion 2; Inhalation 1
  Chronic Local: Irritant 1
  Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

BENZYL CHLORIDE

Synonym: a-Chlorotoluene.
Description: Colorless liquid; aromatic odor.

Formula: $C_6H_5CH_2Cl$
Constants:
  Mol. Wt. 126.58
  M. P. -43°C
  B. P. 179°C
  Flash P. 140°F (C.C.)
  Density 1.1026 @18°/4°C
  Autoign. Temp. 1161°F
  Vap. D. 4.36
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
  Chronic Local: U
  Chronic Systemic: U
MAC: ACGIH (tentative); 1 part per million of air.
Fire Hazard: Moderate, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame. The decomposition can reach explosive violence in presence of metals such as iron.
Explosive Range: 1.1% (L.E.L.)
Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes of phosgene; will react with water or steam to produce toxic and corrosive fumes; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Corrosive liquid; white label.
  Coast Guard Classification: Corrosive liquid; white label.
  MAC warning label.

BENZYL CHLOROCARBONATE.
See Benzyl Chloroformate.

BENZYL CHLOROFORMATE
Synonym: Benzyl chlorocarbonate.
Description: Colorless to pale yellow liquid; odor of phosgene.
Formula: $ClCOOC_6H_5CH_2$
Constant:
  Mol. Wt. 170.6
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene and hydrogen chloride; it will react with water or steam to produce heat, toxic and corrosive fumes.
Ventilation Control (use optional): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Corrosive liquid; white label.
  Coast Guard Classification: Corrosive liquid; white label.

o-BENZYL-p-CHLOROPHENOL
Description: Nearly colorless flakes.
Formula: $C_{13}H_{11}OCl$
Constants:
  Mol. Wt. 218.6
  M. P. 49°C
  B. P. 175°C @5 mm
  Density 1.2 @55°/25°C
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Moderately dangerous; when heated to decomposition, emits toxic fumes.
Ventilation Control (use optional): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

BENZYL CINNAMATE
Synonym: Cinnamein.
Description: White crystals; aromatic odor.
Formula: $C_9H_7O_2C_7H_7$
Constants:
  Mol. Wt. 238.27
  M. P. 39°C
  B. P. 350.0°C
  Vap. Press. 1 mm @173.8°C
Toxic Hazard Rating:
  Acute Local: Irritant 1; Allergen 1; Ingestion 1; Inhalation 1

Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

BENZYL CYANIDE

Synonym: Phenyl acetonitrile.
Description: Oily liquid; aromatic odor.
Formula: C_8H_7N
Constants:
Mol Wt. 117.1
M. P. −23.8°C
B. P. 233.5°C
Density 1.0214 @15°/15°C
Vap. D. 4.03
Toxicity: See Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

BENZYL DIETHYLAMINE

Description: Liquid.
Formula: $C_6H_5CH_2N(C_2H_5)_2$
Constants:
Mol. Wt. 163.26
B. P. 207 - 216°C
Flash P. 170°F (O.C.)
Density 0.89
Vap. D. 5.6
Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BENZYL IODIDE

Synonym: a-Iodotoluene.
Description: Colorless crystals.
Formula: $C_6H_5CH_2I$
Constants:
Mol. Wt. 218.05
M. P. 24°C
B. P. 93°C @10 mm
Density 1.733 @25°/4°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Moderately dangerous; when heated to decomposition, emits toxic fumes of iodides.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

BENZYL MERCAPTAN

Synonyms: alpha-toluene thiol; phenyl methane thiol.
Description: A water-white, mobile liquid; strong odor.
Formula: C_7H_8S
Constants:
Mol. Wt. 124.2
B. P. 194.8°C
Flash P. 158°F (C.C.)
Density 1.058 @20°C
Vap. D. 4.28
Toxicity: Details unknown. See also Mercaptans and Benzene.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition and on contact with acid or acid fumes, emits highly toxic fumes; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

BENZYL NICOTINIUM CHLORIDE

Description: Crystals.
Formula: $C_{10}H_{14}N_2Cl(C_6H_5CH_2Cl)$
Constant:
Mol. Wt. 288.8
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 1; Ingestion 3; Inhalation 2
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: Irritant 2; Allergen 1
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes of phosgene.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3

Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

p-BENZYL OXYPHENOL
Description: Crystals.
Formula: $C_6H_5CH_2OC_6H_5$
Constant:
Mol. Wt. 184.2
Toxicity: Details unknown. See also Phenol.
Fire Hazard: Slight, in the presence of heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

o-BENZYL PHENOL
Synonym: (2-Hydroxydiphenyl) methane.
Description: Crystals or liquid.
Formula: $C_6H_5CH_2C_6H_4OH$
Constants:
Mol. Wt. 184.2
M. P. 20°C
B. P. 154 - 156°C @10 mm
Toxicity: Details unknown. See also Phenol.
Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes.
Storage and Handling: Section 7

p-BENZYL PHENOL
Synonym: (4-Hydroxydiphenyl) methane.
Description: Crystals; colorless to slightly pink powder; faintly pleasant phenolic odor.
Formula: $C_6H_5CH_2C_6H_4OH$
Constants:
Mol. Wt. 184.23
M. P. 84°C
B. P. 313°C
Density 1.10 @25°/25°C
Toxicity: Details unknown. See also Phenol.
Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes.
Storage and Handling: Section 7

BENZYL PYRIDINE
Formula: $C_6H_5CH_2C_5H_4N$
Constant:
Mol. Wt. 169.2
Toxicity: Details unknown. See also Pyridine.
Fire Hazard: A moderately flammable material (Section 6).
Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

BENZYL SALICYLATE
Description: Thick liquid; pleasant odor.
Formula: $HOC_6H_4CO_2CH_2C_6H_5$
Constants:
Mol. Wt. 228.2
B. P. 208°C @26 mm
Density 1.175 @20°C
Toxicity: Details unknown. See also Benzyl Alcohol and Salicylic Acid.
Fire Hazard: Slight when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

BENZYL THIOCYANATE
Synonym: Benzyl mustard oil.
Description: Orange-red crystalline solid.
Formula: $C_6H_5CH_2CNS$
Constants: Mol. Wt. 149.2
M. P. 41°C
B. P. 230°C
Density 1.125
Toxicity: Details unknown. See also Thiocyanates.
Fire Hazard: Moderately flammable (Section 6).

BENZYLTRIMETHYL AMMONIUM CHLORIDE
Description: Thick liquid.
Formula: $C_6H_5CH_2N(CH_3)_3Cl$
Constants:
Mol. Wt. 185.7
B. P. > 135°C (Decomp.)
Freezing P. < −50°C (61% sol.)
Density 1.07 @20°/20° (61% sol.)
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

N-BENZYL-N,N,N-TRIMETHYL AMMONIUM HEXAFLUOPHOSPHATE
Description: Crystals.

Formula: $C_6H_5CH_2N(CH_3)_3PF_6$
Constants:
  Mol. Wt. 295
  M. P. 1.52°C
Toxicity: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, or on contact with acid or acid fumes, emits highly toxic fumes.
Storage and Handling: Section 7

BENZYL TRIMETHYL AMMONIUM HYDROXIDE

Description: Solid.
Formula: $C_6H_5CH_2N(CH_3)_3OH$
Constant:
  Mol. Wt. 150.3
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2
  Acute Systemic: Ingestion 3
  Chronic Local: Irritant 2
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat; can react with oxidizing materials; products of heat decomposition are flammable (Section 6).
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

BERBERINE

Description: White to yellow crystals.
Formula: $C_{20}H_{17}NO_4 \cdot 6H_2O$
Constants:
  Mol. Wt. 443.44
  M. P. Anh. 145°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: U
Toxicology: An alkaloid poison. In toxic doses it lowers the temperature, increases peristalsis, and causes death by central paralysis.
Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7. Should carry a poison label. Should never be ingested without the advise of a physician. Should not be handled excessively, since it may be absorbed through the skin and have a toxic effect upon the body.

BERBERINE COMPOUNDS. See Berberine.

BERGAMOT OIL

Description: Yellow-green liquid; agreeable odor.
Composition: l-linaylacetate, l-linalool, d-limonene, dipentene, bergaptene.
Constant:
  Density 0.875 - 0.880 @25°/25°C
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight; when heated, emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

BERYL

Description: Green, blue, yellow or white crystals.
Formula: $3BeO \cdot Al_2O_3 \cdot 6SiO_2$
Constant:
  Density 2.63 - 2.91
Toxicity: Details unknown. Probably has little toxicity of itself as it has not been known to cause pneumoconiosis. See also Beryllium.
Ventilation Control (use normal rate): Section 2

BERYLLIUM

Synonym: Glucinum
Description: A grayish-white, hard light metal.
Formula: Be
Constants: At. Wt. 9.013
  M. P. 1278°C
  B. P. 2970°C
  Density 1.85
Toxic Hazard Rating:
  Acute Local: Inhalation 3
  Acute Systemic: Inhalation 3
  Chronic Local: Irritant 1; Inhalation 3
  Chronic Systemic: Ingestion 3; Inhalation 3
Radiation Hazard (Section 5): Artificial isotope Be^7, half-life 53.7

days; emits gamma rays of 0.48 mev. The permissible levels are: In body: 670 microcuries. In air: 4×10^{-6} microcurie per milliliter. In water: 1 microcurie per milliliter. Artificial isotope Be^{10}, half-life: 2.7×10^6 years; emits beta particles of 0.56 mev.
Fire Hazard: Moderate, in form of dust or powder; or when exposed to flame by spontaneous chemical reaction (Section 6).
Explosion Hazard: Slight, in the form of powder or dust.
Ventilation Control (use high rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Metal powder, Poison B; poison label.
  Coast Guard Classification: Metal powder, Poison B; poison label.

BERYLLIUM ACETATE
Description: Plates.
Formula: $Be(C_2H_3O_2)_2$
Constants:
  Mol. Wt. 127.10
  M. P. Decomposes 300°C
Toxicity: See Beryllium Compounds.

BERYLLIUM ALGINATE
Toxicity: See Beryllium Compounds.

BERYLLIUM ALUMINATE
Synonym: Chrysoberyl.
Description: Rhombic crystals.
Formula: $BeAl_2O_4$
Constants:
  Mol. Wt. 126.95
  Density 3.76
Toxicity: See Beryl
Ventilation Control (use normal rate): Section 2

BERYLLIUM ALUMINUM SILICATE
Synonym: Euclase.
Description: Monoclinic crystals.
Formula: $Be_2Al_2(SiO_4)_2(OH)_2$
Constants:
  Mol. Wt. 290.12
  Density: 3.1
Toxicity: See Beryl
Ventilation Control (use moderate rate): Section 2

BERYLLIUM BENZENESULFONATE
Description: Monoclinic crystals.
Formula: $Be(C_6H_5O_3S)_2$
Constant:
  Mol. Wt. 323.35
Toxicity: See Beryllium Compounds.
Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes of Beryllium oxide and oxides of sulfur.
Storage and Handling: Section 7

BERYLLIUM o-BORATE, BASIC
Synonym: Hambergite.
Decription: Rhombic crystals.
Formula: $Be_2(OH)BO_3$
Constants:
  Mol. Wt. 93.85
  Density 2.35
Toxicity: See Beryllium Compounds.

BERYLLIUM BOROHYDRIDE
Description: Solid.
Formula: $Be(BH_4)_2$
Constant:
  Mol. Wt. 38.72
  M. P. 123°C; sublimes @91°C
  Vap. Press. 10 mm @28.1°C
Toxicity: See Beryllium Compounds, Boron Compounds and Hydrides.
Fire Hazard: Moderate, when exposed to heat or by spontaneous chemical reaction with oxidizing agents (Section 6).
Disaster Control: Dangerous, will react with water or steam to produce heat and hydrogen; can react vigorously with oxidizing materials; and on contact with acid or acid fumes, emits toxic fumes.
Storage and Handling: Section 7

BERYLLIUM BROMIDE
Description: White deliquescent needles.
Formula: $BeBr_2$
Constants:
  Mol. Wt. 168.85
  M. P. 490°C; sublimes @474°C
  B. P. 520°C
  Density 3.465 @25°C
Toxicity: See Beryllium Compounds.

BERYLLIUM BUTYRATE, BASIC
Description: Crystals.
Formula: $Be_4O(C_4H_7O_2)_6$

Constants:
Mol. Wt. 574.6
B. P. 239 @19 mm
Toxicity: See Beryllium Compounds.
Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes of beryllium oxide.
Storage and Handling: Section 7

BERYLLIUM CARBIDE

Description: Hexagonal yellow crystals.
Formula: Be_2C
Constants:
Mol Wt. 30.0
M. P. > 2100°C Decomposes
Density 1.90 @15 C
Toxicity: See Beryllium Compounds.
Fire Hazard: Details unknown. See also Carbides.
Explosion Hazard: Details unknown. See also Carbides.
Disaster Control: Dangerous; will react with water or steam to produce flammable vapors and highly toxic fumes of beryllium oxides.
Storage and Handling: Section 7

BERYLLIUM CARBONATE, BASIC

Description: White powder.
Formula: $BeCO_3 + Be(OH)_2$
Constant:
Mol. Wt. 112.05
Toxicity: See Beryllium Compounds.

BERYLLIUM CHLORIDE

Description: Colorless deliquescent needles.
Formula: $BeCl_2$
Constants:
Mol. Wt. 79.93
M. P. 440°C
B. P. 520°C
Density 1.899 @25°C
Vap. Press. 1 mm @291°C (sublimes)
Toxicity: See Beryllium Compounds.

BERYLLIUM COMPOUNDS

Toxic Hazard Rating:
Acute Local: Inhalation 3
Acute Systemic: Inhalation 3
Chronic Local: Irritant 1; Inhalation 3
Chronic Systemic: Ingestion 3; Inhalation 3
Toxicology: The extraction of beryllium from its ore is attended by exposure to acid salts of the metal, particularly the fluoride (BeF_2), the ammonium fluoride, and the sulfate ($BeSO_4$), and also to beryllium oxide)BeO), and hydroxide [$Be(OH)_2$]. Exposure to the oxide also occurs in the casting of beryllium alloys and in operations with beryllia ceramics. In the manufacture of fluorescent powders, lamps and sign tubes there may be exposure to beryllium carbonate and to more complex salts, such as zinc manganese beryllium silicate.

Beryllium compounds can enter the body through inhalation of the dusts and fumes and they may act locally on the skin. Exposure to beryllium compounds encountered in the extraction of the metal or its oxide from the ore, particularly the halide salts, has been attended, in certain individuals, by the development of dermatitis of an edematous and papulovesicular type (Section 9), chronic skin ulcers, rhinitis, nasopharyngitis, epistaxis, bronchitis and in severe cases, by the development of an acute pneumonits, with cough, scanty sputum, low-grade fever, rales, dyspnea and substernal pain. Radiographs show diffues haziness throughout both lungs, followed by the appearance of soft, ill-defined opacities. The condition usually occurs while the worker is exposed, sometimes within one or two months of starting work, and recovery occurs within two months, as a rule, though radiographic changes sometimes persist for longer periods. Certain investigators have reported occasional failure of complete resolution, followed by fibrosis. In severe cases of pneumonitis the patient may die. Nercopsies have revealed diffuse pulmonary edema, hemorrhagic extravasation, large numbers of plasma cells and a relative absence of polymorphonuclear infiltration. On the basis of experimental work with animals, certain investigators are of the opinion that the acute upper and lower respiratory effects are due chiefly to the acid radical present in the dust or fume, but this view has little support.

A delayed form of lung disease, characterized by the occurrence of granulomatous areas in the lung tissue, has been reported in workers manufacturing florescent powders, lamps and sign tubes, casting beryllium master alloys, and in the production of beryllium from beryl ore. Symptoms can start during exposure, but they might be delayed up to 5 years or more after leaving work. The commonest symptoms are coughing, shortness of breath, loss of appetite, loss of weight, and fatigue. Rales are usually present in the bases and axillae, and the red cell count is frequently elevated. Cyanosis is common and the pulse and respiratory rates are often increased. Radiographically, three stages of the disease are described: (1) a diffuse, uniform granular shadowing extending throughout both lung fields; (2) a diffuse reticular pattern on the granular background; (3) the appearance of distinct nodules scattered through the lungs, with some enlargement and blurring of the hilar shadows. The intensity of the shadowing is usually greater in the middle third of the lung fields. The prognosis is poor. Clinical improvement may occur gradually over a period of several years, but there appears to be little tendency for the radiographic shadowing to clear. In certain cases, the disease has progressed gradually for some months or years, with death resulting from respiratory and cardiac failure. In several instances necropsies have shown the presence of a diffuse fibrosis with coarse strands of hyalinized collagen between the alveoli and, in some places, replacing them. The hyalinized areas contained granulomatous foci, the alveolar walls are thickened and fibrosed, the blood vessels being engored and dilated. In some cases the hilar lymph nodes show granulomatous change and fibrosis. Granulomatous change has also been noted in the liver and hyaline fibrosis in the spleen. Two cases of delayed lung disease not coming to autopsy have presented papular lesions on the dorsum of the hands; on biopsy these showed "sacroid-like" lesions with central necrosis.

Several cases have been reported in which localized granulomatous lesions developed following penetrating wounds caused by splinters of glass from broken fluorescent light tubes. Several weeks or months following the accident, swellings were noted in the injured areas and excision revealed granulomatous tumors, which in one case was shown to contain beryllium. Several cases of beryllium granuloma have been reported in persons residing near processing plants and in families of beryllium workers.

There is no specific treatment, but temporary remissions have been produced by ACTH and cortisone.

Ventilation Control (use high rate): Section 2
Personal Hygiene: Section 3
Personnel Protection: Section 3
First Aid: Section 1

BERYLLIUM-COPPER ALLOY

Description: A metallic alloy.
Formula: Be_xCu_y
Toxicity: See Beryllium Compounds.

BERYLLIUM ETHYL, See Diethyl Beryllium.

BERYLLIUM FLUORIDE

Description: Amorphous, colorless mass.
Formula: BeF_2
Constants:
Mol. Wt. 47.02
M. P. 800°C
Density 1.986 @ 25°C
Toxicity: See Beryllium Compounds and Fluorides.

BERYLLIUM FORMATE

Description: Crystals.
Formula: $(Be(COOH)_2)_x$
Constants: Mol. Wt. $(99.1)_x$
M. P. Decomposes @ 150°C

Toxicity: See Beryllium Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of beryllium oxide.
Storage and Handling: Section 7

BERYLLIUM HYDROXIDE

Description: White amorphous powder or crystals.
Formula: $Be(OH)_2$
Constants:
Mol. Wt. 43.04
M. P. Decomposes @138°C
Density 1.909 (cr)
Toxicity: See Beryllium Compounds.

BERYLLIUM IODIDE

Description: Colorless needles.
Formula: BeI_2
Constants:
Mol. Wt. 262.85
M. P. 480°C
B. P. 488°C
Density 4.325 @25°C
Vap. Press. 1 mm @283°C
Toxicity: See Beryllium Compounds.

BERYLLIUM NITRATE

Description: White, yellowish crystals; deliquescent.
Formula: $Be(NO_3)_2 \cdot 3H_2O$
Constants:
Mol. Wt. 187.08
M. P. 60°C
B. P. Decomposes 100 - 200°C
Toxicity: See Beryllium Compounds and Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, emits highly toxic fumes of oxides of nitrogen and beryllium; can react vigorously with reducing materials.
Storage and Handling: Section 7

BERYLLIUM NITRIDE

Description: Cubic colorless crystals.
Formula: Be_3N_2
Constants:
Mol. Wt. 55.06
M. P. 2200 ± 100°C
B. P. Decomposes 2240°C
Toxicity: See Beryllium Compounds.
Fire Hazard: Details unknown. See also Nitrides.
Explosion Hazard: Details unknown. See also Nitrides.
Disaster Control: Dangerous, will react with water or steam to produce toxic fumes.
Storage and Handling: Section 7

BERYLLIUM OXALATE

Description: Rhombic crystals.
Formula: $BeC_2O_4 \cdot 3H_2O$
Constants:
Mol. Wt. 151.08
M. P. $-2H_2O$ @100°C; $-3H_2O$ @ 220°C
B. P. Decomposes @350°C
Toxicity: See Beryllium Compounds and Oxalates.

BERYLLIUM OXIDE

Synonym: Bromellete.
Description: White or amorphous powder.
Formula: BeO
Constants:
Mol. Wt. 25.0
M. P. 2530 ± 30°C
B. P. 3900°C (approx.)
Density 3.025
Toxicity: See Beryllium Compounds.

BERYLLIUM 2,4- PENTANEDIONE DERIVATIVE

Description: Monoclinic white crystals.
Formula: $Be(C_5H_7O_2)_2$
Constants:
Mol. Wt. 207.23
M. P. 108°C
B. P. 270°C
Density 1.168 @4°C
Toxicity: See Beryllium Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of beryllium oxide.
Storage and Handling: Section 7

BERYLLIUM m- PHOSPHATE

Description: Crystals.
Formula: $Be(PO_3)_2$
Constant:
Mol. Wt. 167.0
Toxicity: See Beryllium Compounds.

BERYLLIUM o- PHOSPHATE

Description: Crystals.
Formula: $Be_3(PO_4)_2 \cdot 3H_2O$
Constants:
Mol. Wt. 271.05

M. P. $-H_2O$ @100°C
Toxicity: See Beryllium Compounds.

BERYLLIUM POTASSIUM FLUORIDE

Synonym: Glucinum potassium fluoride.
Description: White crystal masses.
Formula: $GlF_2 \cdot (KF)_2$; $BeF_2 \cdot (KF)_2$
Constant:
Mol. Wt. 163.30
Toxicity: See Beryllium Compounds and Fluorides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it may emit highly toxic fumes of fluorides of beryllium oxide.
Storage and Handling: Section 7

BERYLLIUM PROPIONATE ACETATE, BASIC

Description: Crystals.
Formula: $Be_4O(C_2H_3O_2)_3\text{-}(C_3H_5O_2)_3$
Constants:
Mol. Wt. 448.39
M. P. 127°C
B. P. 330°C
Toxicity: See Beryllium Compounds.
Disaster Control: Dangerous; when heated to decomposition, it may emit toxic fumes of beryllium oxide.
Storage and Handling: Section 7

BERYLLIUM SODIUM-FLUORIDE

Synonym: Glucinum sodium fluoride.
Description: White crystalline mass.
Formula: $BeF_2 \cdot (NaF)_2$
Constant:
Mol. Wt. 131.10
Toxicity: See Beryllium Compounds and Fluorides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, emits highly toxic fumes of fluorides and possibly of beryllium oxide.
Storage and Handling: Section 7

BERYLLIUM STEARATE

Description: White waxy crystals.
Formula: $Be(C_{18}H_{35}O_2)_2$
Constants: Mol. Wt. 575.94
M. P. 45°C
Toxicity: See Beryllium Compounds.
Disaster Control: Dangerous; when heated to decomposition, it may emits toxic fumes of beryllium.
Storage and Handling: Section 7

BERYLLIUM SULFATE

Description: Crystals.
Formula: $BeSO_4$
Constants:
Mol. Wt. 105.08
M. P. 550 - 600°C (Decomp.)
Density 2.443
Toxicity: See Beryllium Compounds.

BERYLLIUM SULFIDE

Description: Solid crystalline mass.
Formula: BeS
Constants:
Mol. Wt. 41.08
Density 2.36
Toxicity: See Beryllium Compounds and Sulfides.
Fire Hazard: See Sulfides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur and beryllium oxide; will react with water or steam to produce toxic fumes and flammable vapors.
Storage and Handling: Section 7

BERYLLIUM ZINC SILICATE

Description: Crystalline solid.
Formula: $BeZn(SiO_4)$
Constant:
Mol. Wt. 166.5
Toxicity: See Beryllium Compounds.

BETA RAYS

Description: Particulate radiation emitted by certain radioactive isotopes. Beta rays consist of electrons moving at high velocity.
Radiation Hazard: See Section 5 for complete discussion.

BICHROMATE OF SODA. See Sodium Dichromate.

BICYCLOHEXYL

Synonym: Dicyclohexyl.
Description: Colorless oil; pleasant odor.
Formula: $C_{12}H_{22}$
Constants:
Mol. Wt. 166.3
M. P. 2°C
B. P. 240°C
Flash P. 215°F

Density 0.883 @25°/15.6°C
Autoign. Temp. 220°F
Vap. D. 5.73
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BI-(ETHYL MERCURIC) PERTHIOCYANATE

Toxicity: See Mercury Compounds, Organic.
Disaster Control: See Mercury Compounds, Organic and Thiocyanates.
Storage and Handling: Section 7

BIG REDS. See Explosives, High.

2-BIPHENYLYLDIPHENYL PHOSPHATE

Description: Clear mobile liquid.
Formula: $C_{24}H_{19}O_4P$
Constants:
Mol. Wt. 402.37
M. P. < 0°C
B. P. 250 - 285°C @5 mm
Flash P. 437°F
Density 1.2 @60°>4°C
Vap. D. 13.8
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes of oxides of phosphorus; can react with oxidizing materials.
Storage and Handling: Section 7

1-(4-BIPHENYLYLOXY)-2-PROPANOL

See Propylene Glycol-4-Biphenylyl Ether.

BIRCH TAR OIL

Description: Brown liquid; leather-like odor.
Constant:
Density 0.886 - 0.950
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 1; Ingestion 2
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

BIRCH WOOD DUST

Description: A typical wood dust.
Toxic Hazard Rating:
Acute Local: Allergen 1; Inhalation 1
Acute Systemic: 0
Chronic Local: Allergen 1
Chronic Systemic: Inhalation 1
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).

BIS(o-AMINO PHENYL DISULFIDE)

Toxicity: Details unknown; an insecticide.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

2,2-BIS(p-BROMOPHENYL)-1,1,1-TRICHLOROETHANE

Formula: $C_{14}H_9Br_2Cl_3$
Constant:
Mol. Wt. 443.43
Toxicity: Details unknown.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of phosgene.
Storage and Handling: Section 7

BIS(2-BUTYL OCTYL) SODIUM SULFOSUCCINATE

Description: White waxy pellets.
Formula:
$(C_{12}H_{25}O_2C)_2CH_2CHSO_3Na$
Constants:
Mol. Wt. 556
M. P. > 200°C
Density 1.0 @25°C
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

2, 2-BIS(tert-BUTYLPEROXY) BUTANE

Synonym: 22-PB
Description: Liquid.
Formula: $(CH_3)_3COOC(CH_3)_2OOC(CH_3)_3$
Constants:
Mol. Wt. 220.3
M. P. -10° to -26°C
Flash P. 84°F (O.C.)
Density 0.8655 @20°/4°C
Vap. D. 7.59
Toxicity: Unknown
Fire Hazard: Dangerous; it burns when exposed to heat or flame or by spontaneous chemical reaction with reducing agents.
Caution: This is an oxidizer as well as a flammable material.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7

BIS(2-p-tert-BUTYLPHENOXY ETHYL) SODIUM SULFOSUCCINATE

Description: White powder.
Formula: $(C_{12}H_{17}OCO_2)_2CH_2SCHO_3Na$
Constants:
Mol. Wt. 540
M. P. 130 - 140°C
Density 1.0 @25°C
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

BIS(p-tert-BUTYL PHENYL) PHENYL PHOSPHATE

Description: Clear viscous liquid.
Formula: $C_{26}H_{31}O_4P$
Constants:
Mol. Wt. 438.49
B. P. 260 - 275°C @5 mm
Freezing P. < 0°C
Flash P. 482°F
Density 1.11 @25°/25°C
Vap. D. 15.1
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus; can react with oxidizing materials.
Ventilation Control (use optional): Section 2
Storage and Handling: Section 7

BIS(5-CHLORO-2-HYDROXYPHENYL) METHANE

Formula: $(C_6H_3Cl(OH)_2CH_2)$
Constant:
Mol. Wt. 158.6
Toxicity: Details unknown; an insecticide.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

BIS(p-CHLOROPHENOXY METHANE)

Synonyms: Di(4-chlorophenoxy) methane.
Description: White crystals.
Formula: $C_{13}H_{10}Cl_2O_2$
Constants:
Mol. Wt. 269.1
M. P. 67 - 68°C
Toxicity: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

2, 2-BIS-(p-CHLOROPHENYL)-1, 1-DICHLOROETHANE. See DDD

BIS-(o-CHLOROPHENYL) PHENYL PHOSPHATE

Description: Clear, pale straw colored mobile liquid.
Formula: $C_{18}H_{13}O_4Cl_2P$
Constants:
Mol. Wt. 395.18
M. P. < 0°C
B. P. 255 - 275°C @5 mm
Flash P. > 437°F
Density 1.34 @25°/25°C
Vap. D. 13.6
Toxicity: Unknown.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes of chlorides

and oxides of phosphorus; can react with oxidizing materials.
Ventilation Control (use optional): Section 2
Storage and Handling: Section 7

2, 2-BIS-(p-CHLOROPHENYL)-1, 1, 1-TRICHLOROETHANE. See DDT

BIS(DIETHYLTHIOCARBAMYL) DISULFIDE

Synonym: Tetraethylthiuram disulfide.
Description: Powder.
Formula: $C_{10}H_{20}N_2S_4$
Constant: Mol. Wt. 296.5
Toxicity: Details unknown, but toxic when accompanied by ingestion of alcohol.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur and nitrogen.
Storage and Handling: Section 7

BIS(1, 3-DIMETHYLBUTYL) AMINE

Description: Liquid.
Formula: $[CH_3CH(CH_3)CH_2CH(CH_3)]_2NH$
Constants:
- Mol. Wt. 185.2
- B. P. 190 - 200°C
- Density 0.775 @20°/20°C
- Vap. D. 6.38

Toxicity: Details unknown. See also Amines.
Fire Hazard: Slight; when heated, it emits smoke (Section 6).
Storage and Handling: Section 7

BIS(DIMETHYLTHIOCARBAMYL) DISULFIDE

Synonym: Tetramethylthiuram disulfide.
Description: Powder.
Formula: $C_6H_{12}N_2S_4$
Constant:
- Mol. Wt. 240.44

Toxic Hazard Rating:
- Acute Local: U
- Acute Systemic: 2
- Chronic Local: U
- Chronic Systemic: Ingestion 2; Inhalation 2

Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes of oxides of nitrogen and sulfur.
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

1, 3-BIS-ETHYLAMINOBUTANE

Description: Liquid.
Formula: $(C_2H_5)_2C_4H_7NH_2$
Constants:
- Mol. Wt. 129.2
- B. P. 354°F
- Flash P. 115°F
- Density 0.81
- Vap. D. 4.44

Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: i Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BIS(2-ETHYLHEXYL)-2-ETHYLHEXYLPHOSPHONATE

Description: Colorless liquid, very mild odor.
Formula: $C_8H_{17}P(O)(OC_8H_{17})_2$
Constants:
- Mol. Wt. 418.6
- B. P. 161°C @0.25 mm
- Flash P. 419°F (C. O. C.)
- Density 0.908 @20°/4°C
- Vap. D. 14.4

Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorous; can react with oxidizing materials.
Storage and Handling: Section 7

BIS-(2-HYDROXY-5-CHLORO-PHENYL) SULFIDE

Formula: $(C_6H_3OHCl)_2S$
Constant:
- Mol. Wt. 287.2

Toxicity: Details unknown; a fungicide.
Fire Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of sulfur.
Storage and Handling: Section 7

BIS-(2-HYDROXY-3, 5-DICHLOROPHENYL) SULFIDE

Description: Odorless, tasteless, white crystalline solid.
Formula: $C_{12}H_6Cl_4O_2S$
Constants:
Mol. Wt. 356.1
M. P. 187 - 188°C
Density 1.73
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of sulfur.
Storage and Handling: Section 7

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Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U

2, 2-BIS(p-METHOXYPHENYL)-1, 1, 1-TRICHLOROETHANE. See Methoxychlor.

BIS-alpha-METHYL BENZYL ETHER. See Methyl Benzyl Ether.

BISMUTH

Description: Hexagonal silver-white or reddish metallic crystals.
Formula: Bi
Constants:
At. Wt. 209.00
M. P. 271.3°C
B. P. 1420 - 1560°C
Density 9.80
Vap. Press. 1 mm @ 1021°C
Toxicity: See Bismuth Compounds.
MAC: 2 milligrams per cubic meter of air.
Radiation Hazard (Section 5): Natural isotope Bi^{210} (Radium E), half-life: 5.0 days; emits beta particles of 1.17 mev. Bi^{210} is a member of the uranium series. It is the immediate daughter of Pb^{210} and parent of Po^{210}. Hazard Rating, Class III (National Bureau of Standards Handbook No. 42).

Natural isotope Bi^{214} (Radium C), half-life: 19.7 minutes; emits beta particles of 1.65 mev (80%) and 3.17 mev (20%) and many gamma rays between 0.4-2.4 mev. Bi^{214} is a member of the uranium series and is only considered a possible hazard as a daughter of Rn^{222} (radon).

Natural isotope Bi^{212}, half-life: 60.5 minutes; emits alpha particles of 6.0 mev (75%) and 6.1 mev (25%), beta particles of 2.25 mev and many gamma rays between 0.7-2.2 mev. Bi^{212} is a member of the thorium series. With its short half-life it is only considered a hazard as a daughter of Rn^{220}(thoron). One-third of the Bi^{212} atoms decay by alpha emmission, the other two-thirds by beta emmission.
Fire Hazard: Moderate; when exposed to flame and by chemical reaction with oxidizing agents.
Disaster Control: Moderately dangerous; can react with acid or acid fumes to emit toxic fumes.
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

BISMUTH ACETATE

Description: White crystals.
Formula: $Bi(C_2H_3O_2)_3$
Constants:
Mol. Wt. 386.13
M. P. Decomposes
Toxicity: See Bismuth Compounds.

BISMUTH (COLLOIDAL SOLUTION)

Toxicity: Details unknown. See also Bismuth Compounds.

BISMUTH o-ARSENATE

Description: Monoclinic crystals.
Formula: $BiAsO_4$
Constants:
Mol. Wt. 347.91
Density 7.14
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

BISMUTH BENZOATE

Description: White powder.
Formula: $Bi(C_7H_5O_2)_3$
Constant:
Mol. Wt. 572.33
Toxicity: See Bismuth Compounds.
Fire Hazard: Slight; when heated, it emits smoke (Section 6).
Storage and Handling: Section 7

BISMUTH CARBONATE, BASIC
Synonyms: Bismuth oxycarbonate, bismutospherite.
Description: White powder.
Formula: $Bi_2O_2CO_3$
Constants:
  Mol. Wt. 510.01
  M. P. Decomposes
  Density 6.86
Toxicity: See Bismuth Compounds.

BISMUTH CITRATE
Description: White crystals.
Formula: $BiC_6H_5O_7$
Constants:
  Mol. Wt. 398.10
  M. P. Decomposes
  Density 3.458
Toxicity: See Bismuth Compounds.

BISMUTH COMPOUNDS
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 1
  Chronic Local: U
  Chronic Systemic: Ingestion 1; Inhalation 1
MAC: 2 milligrams per cubic meter of air.
Toxicology: Bismuth and its salts can cause kidney damage, although the degree of such damage is usually mild. It is considered one of the less toxic of the heavy metals, although intoxication has occurred from its use in medicine. The similarity between the pharmacologic and toxic behavior of lead and bismuth has been pointed out in the literature. Like lead, bismuth may be liberated from tissue deposits during periods of acidosis. Serious and sometimes fatal poisoning may occur from the injection of large doses into closed cavities and from extensive application to burns.

Death of animals from bismuth nephritis following injections of soluble salts (bismuth) occurs within several hours to 24 days, the time being generally inversely proportional to the dose, and it appears to be in the order of 5 to 10 times higher than the dose by slow intravenous injection for rabbits. It is stated that the administration of bismuth should be stopped when gingivitis appears, for otherwise serious ulcerative stomatitus is likely to result. Other toxic results may develop, such as malaise, albuminuria, diarrhea, skin reactions, and sometimes serious exodermatitis.

Industrial bismuth poisoning has not been reported, although bismuth absorbed in industrial cases may complete a diagnosis of plumbism, since the dark line in the gums which is often present in lead poisoning is also produced by bismuth.

Treatment and Antidotes: Personnel showing some of the symptoms noted above which might indicate that they were absorbing too much bismuth into the body should be removed from exposure as soon as possible. Get medical advice.

Bismuth and its salts should be labeled as poison. Personnel should be cautioned against careless handling of these materials.

Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

BISMUTH DICHROMATE, BASIC
Description: Yellow or red crystals.
Formula: $(BiO)_2Cr_2O_7$
Constant:
  Mol. Wt. 666
Toxicity: See Chromium Compounds and Bismuth Compounds.
Fire Hazard: Moderate, by chemical reaction with easily combustible materials; can react with reducing materials; a powerful oxidizer.
Storage and Handling: Section 7

BISMUTH ETHYL CHLORIDE
Description: Powder.
Formula: $BiHC_2H_5Cl$
Constant:
  Mol. Wt. 274.5
Toxicity: See Bismuth Compounds.
Fire Hazard: Dangerous, by spontaneous chemical reaction; also spontaneously flammable in air (Section 6).
Explosion Hazard: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; can

react with oxidizing materials.
Storage and Handling: Section 7

BISMUTH GALLATE, BASIC
Synonyms: Subgallate; dermatol (com'l)
Description: Yellow amorphous crystals.
Formula: $Bi(OH)_2C_7H_5O_5$ (approx.)
Constants:
Mol. Wt. 412.13
M. P. Decomposes
Toxicity: See Bismuth Compounds.

BISMUTH HEPTADIENE-CARBOXYLATE
Toxicity: See Bismuth Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

BISMUTH HEPTOXIDE
Toxicity: See Bismuth Compounds.
Fire Hazard: Moderate, by chemical reaction with easily oxidized materials; can react with reducing materials; a powerful oxidizer (Section 6).
Storage and Handling: Section 7

BISMUTH HYDROXIDE
Description: White amorphous powder.
Formula: $Bi(OH)_3$
Constants: Mol. Wt. 260.02
$-H_2O$ @100°C,
$-1\frac{1}{2}\ H_2O$ @400°C
decomp. @415°C
Toxicity: See Bismuth Compounds.

BISMUTH IODATE
Description: White crystals.
Formula: $Bi(IO_3)_3$
Constant:
Mol. Wt. 733.76
Toxicity: See Bismuth Compounds and Iodates.
Fire Hazard: Moderate, by spontaneous chemical reaction with easily oxidized materials; a powerful oxidizer (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits highly toxic fumes; can react with reducing materials.
Storage and Handling: Section 7

BISMUTH dl-LACTATE
Description: Prisms.
Formula: $Bi(C_6H_9O_6) \cdot 7H_2O$
Constant:
Mol. Wt. 512.25
Toxicity: See Bismuth Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

BISMUTH MOLYBDATE
Description: Tetragonal needles.
Formula: $Bi_2(MoO_4)_3$
Constants:
Mol. Wt. 897.85
M. P. 643°C
Density 6.07
Toxicity: See Bismuth Compounds and Molybdenum Compounds.

BISMUTH MONOSULFIDE
Description: Gray crystals.
Formula: BiS
Constants: Mol. Wt. 241.07
M. P. 685°C
Density 7.7
Toxicity: See Bismuth Compounds and Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur; will react with water or steam to produce toxic and flammable vapors.
Storage and Handling: Section 7

BISMUTH NITRATE
Description: Triclinic, colorless, slightly hygroscopic crystals.
Formula: $Bi(NO_3)_3 : 5H_2O$
Constants: Mol. Wt. 485.10
$-5H_2O$ @80°C
Density 2.83
Toxicity: See Bismuth Compounds and Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

BISMUTH OXALATE
Description: White powder.
Formula: $Bi_2(C_2O_4)_3$
Constant: Mol. Wt. 682.06
Toxicity: See Bismuth Compounds and Oxalates.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

BISMUTH OXYBROMIDE
Description: Colorless crystals or white powder.
Formula: BiOBr
Constants:
Mol. Wt. 304.92
Density 8.08
Toxicity: See Bismuth Compounds and Bromides.
Fire Hazard: Slight; on decomposition it emits toxic fumes.
Storage and Handling: Section 7

BISMUTH OXYCHLORIDE
Description: White lustrous crystalline powder.
Formula: BiOCl
Constants:
Mol. Wt. 260.46
M. P. Red heat
Density 7.72
Toxicity: See Bismuth Compounds.
Disaster Control: See Chlorides.
Storage and Handling: Section 7

BISMUTH OXYFLUORIDE
Description: White crystals or powder.
Formula: BiOF
Constants:
Mol. Wt. 244.00
M. P. Decomposes
Density 7.5
Toxicity: See Bismuth Compounds and Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

BISMUTH OXYIODIDE
Description: Red powder.
Formula: BiOI
Constants:
Mol. Wt. 351.92
M. P. Decomposes
Density 7.92
Toxicity: See Bismuth Compounds and Iodides.
Storage and Handling: Section 7

BISMUTH OXYIODOGALLATE
Description: Grayish-green, odorless, tasteless powder.
Formula: $C_6H_2(OH)_3COO(BiOHI)$
Constant:
Mol. Wt. 522.0
Toxicity: See Bismuth Compounds and Iodides.
Disaster Control: See Iodides.
Storage and Handling: Section 7

BISMUTH OXYNITRATE
Description: Hexagonal plates or white powder.
Formula: $BiONO_3 \cdot H_2O$
Constants:
Mol. Wt. 305.02
M. P. Decomposes @ 260°C
Density 4.928 @ 15°C
Toxicity: See Bismuth Compounds and Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

BISMUTH PENTOXIDE
Synonym: m-Bismuthic acid.
Description: Brown or dark red crystals.
Formula: Bi_2O_5
Constants:
Mol. Wt. 498.00
-O @ 150°C;
-2O @ 357°C
Density 5.10
Toxicity: See Bismuth Compounds.
Fire Hazard: Slight, when exposed to heat and oxidizable materials or by chemical reaction with reducing agents; when heated, evolves oxygen (Section 6).

BISMUTH o-PHOSPHATE
Description: Monoclinic white crystals.
Formula: $BiPO_4$
Constants:
Mol. Wt. 303.98
M. P. Decomposes
Density 6.323 @ 15°C
Toxicity: See Bismuth Compounds.

BISMUTH PROPIONATE, BASIC
Description: White powder; faint odor of propionic acid.
Formula: $BiOC_3H_5O_2$
Constant:
Mol. Wt. 298.07
Toxicity: See Bismuth Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

BISMUTH SALICYLATE, BASIC
Synonym: Subsalicylate (commercial)
Description: White microscopic crystals (variable composition)
Formula: $Bi(C_7H_5O_3)_3 \cdot Bi_2O_3$ (approx.)
Constant:
Mol. Wt. 1086.33

Toxicity: See Bismuth Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

BISMUTH SUBNITRATE
Description: White, heavy powder.
Formula: $4BiNO_3(OH)_2 \cdot BiO(OH)$
Constants:
  Mol. Wt. 1462.11
  M. P. Decomposes @ 260°C
  Density 4.928
Toxicity: See Bismuth Compounds.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

BISMUTH SUBSALICYLATE. See Bismuth Salicylate, Basic.

BISMUTH SULFATE
Description: White needles.
Formula: $Bi_2(SO_4)_3$
Constants:
  Mol. Wt. 706.20
  M. P. Decomposes
  Density 5.08 @15°C
Toxicity: See Bismuth Compounds.

BISMUTH TARTRATE
Description: White powder.
Formula: $Bi_2(C_4H_4O_6)_3 \cdot 6H_2O$
Constants:
  Mol. Wt. 970.31
    $-3H_2O$ @105°C
  Density 2.595 @25°C
Toxicity: See Bismuth Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

BISMUTH TELLURATE
Synonym: Montanite.
Description: Powder or crystals.
Formula: $Bi_2TeO_6 \cdot 2H_2O$
Constants:
  Mol. Wt. 677.64
  Density 3.79
Toxicity: See Bismuth Compounds and Tellurium Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of tellurium.
Storage and Handling: Section 7

BISMUTH TETRACHLORIDE
Description: Colorless crystals.
Formula: $BiCl_4$
Constants:
  Mol. Wt. 350.83
  M. P. 225°C
Toxicity: See Bismuth Compounds and Hydrochloric Acid.
Disaster Control: Dangerous; when heated in air, it emits highly toxic fumes of hydrogen chloride; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

BISMUTH TETRAOXIDE
Description: Heavy yellowish-brown powder.
Formula: Bi_2O_4
Constants:
  Mol. Wt. 482
  M. P. 305°C
  Density 5.6
Toxicity: See Bismuth Compounds.
Fire Hazard: Slight, by chemical reaction with reducing agents; an oxidizer (Section 6).
Storage and Handling: Section 7

BISMUTH TRIBROMIDE
Description: Yellow crystalline deliquescent powder.
Formula: $BiBr_3$
Constants:
  Mol. Wt. 448.75
  M. P. 218°C
  B. P. 461°C
  Density 5.7
  Vap. Press. 10 mm @282°C
Toxicity: See Bismuth Compounds, Bromides and Hydrogen Bromide.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of bromides and bromine; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

BISMUTH TRICHLORIDE
Description: White, deliquescent crystals.
Formula: $BiCl_3$
Constants:
  Mol. Wt. 315.37
  M. P. 230°C
  B. P. 441°C
  Density 4.75
  Vap. Press 10 mm @264°C
Toxicity: See Bismuth Compounds

and Hydrochloric Acid.
Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes;
Storage and Handling: Section 7

BISMUTH TRIETHYL
Synonym: Triethyl bismuthine.
Description: Liquid.
Formula: $Bi(C_2H_5)_3$
Constants:
Mol. Wt. 296.2
B. P. 107°C @18 mm
Density 1.82
Toxicity: See Bismuth Compounds.
Fire Hazard: Dangerous, when exposed to heat or by spontaneous chemical reaction; also spontaneously flammable in air; can react with oxidizing materials (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosion Range: Explodes @302°F
Storage and Handling: Section 7

BISMUTH TRIFLUORIDE
Description: Cubic gray crystals.
Formula: BiF_3
Constants:
Mol. Wt. 266.00
Density 8.75
Toxicity: See Fluorides and Bismuth Compounds.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

BISMUTH TRIIODIDE
Description: Hexagonal reddish, brown-gray-blue crystals.
Formula: BiI_3
Constants:
Mol. Wt. 589.76
M. P. 439°C
B. P. Decomposes 500°C
Density 5.7
Toxicity: See Bismuth Compounds and Iodides.
Disaster Control: See Iodides.
Storage and Handling: Section 7

BISMUTH TRIMETHYL
Synonym: Trimethyl bismuthine.
Description: Liquid.
Formula: $Bi(CH_3)_3$
Constants:
Mol. Wt. 254.1
B. P. 110°C
Density 2.300 @18°C
Vap. D. 8.75
Toxicity: See Bismuth Compounds.
Fire Hazard: Dangerous, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7

BISMUTH TRIOXIDE
Description: Rhombic yellow crystals.
Formula: Bi_2O_3
Constants:
Mol. Wt. 466.00
M. P. 820°C
B. P. 1890°C
Density 8.9
Toxicity: See Bismuth Compounds.

BISMUTH TRIPHENYL
Synonym: Triphenyl bismuthine.
Description: Monoclinic crystals.
Formula: $Bi(C_6H_5)_3$
Constants:
Mol. Wt. 440.3
M. P. 78°C
Density 1.585
Toxicity: See Bismuth Compounds and Phenol.
Fire Hazard: Unknown
Explosion Hazard: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, it can evolve toxic fumes.

BISMUTH TRISELENIDE
Synonym: Guanajuatite.
Description: Rhombic black crystals.
Formula: Bi_2Se_3
Constants:
Mol. Wt. 654.88
M. P. 710°C
B. P. Decomposes
Density 6.82
Toxicity: See Bismuth Compounds and Selenium Compounds.
Fire Hazard: Moderate, by chemical reaction with powerful oxidizers. On contact with moisture a flammable gas is evolved (Section 6).
Explosion Hazard: Slight, by

chemical reaction with powerful oxidizers and moisture.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

BISMUTH TRISULFIDE
Synonyms: Bismuthnite; bismuthglance.
Description: Rhombic black crystals.
Formula: Bi_2S_3
Constants: Mol. Wt. 514.20
M. P. 685°C Decomposes
Density 7.39
Toxicity: See Bismuth Compounds and Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

BISMUTH TRITELLURIDE
Synonym: Tetradymite.
Description: Crystals.
Formula: Bi_2Te_3
Constants: Mol. Wt. 800.83
M. P. 573°C
Density 7.7
Toxicity: See Bismuth Compounds and Tellurium Compounds.
Fire Hazard: Moderate by spontaneous chemical reaction with powerful oxidizers; reacts with moisture to evolve a gas (Section 6).
Explosion Hazard: Slight, by chemical reaction with powerful oxidizers; it reacts with moisture.
Disaster Control: See Tellurium Compounds.
Storage and Handling: Section 7

BIS(TRIDECYL)SODIUM SULFOSUCCINATE
Description: White waxy pellets.
Formula: $(C_{13}H_{27}CO_2)_2CH_2SCHO_3Na$
Constants: Mol. Wt. 584
M. P. 70 - 75°C
Density 1.0 @25°C
Toxicity: Unknown
Fire Hazard: Slight; when heated it emits acrid fumes.
Storage and Handling: Section 7

BIS(TRIFLUOROMETHYL)BENZENE
See Xylene Hexafluoride.

BISULFITE DRY POWDER SODA
See Sodium Bisulfite.

BISULFITE OF SODIUM. See Sodium Bisulfite.

BISULFITES
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 1
Acute Systemic: U
Chronic Local: Irritant 2
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of sulfur dioxide; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use optional): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

BITHIONOL
Synonyms: 2,2-Thiobis(4,6-dichlorophenol).
Description: White crystalline powder; very faint phenolic odor.
Formula: $(C_6H_2Cl_2OH)_2S$
Constants:
Mol. Wt. 356.1
M. P. 187 - 188°C
Density 1.61 @25°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: Irritant 1
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

3,3'-BITOLYLENE-4,4'-DIISOCYANATE
Description: Small pale, yellowish flakes.

Formula: $[C_6H_3(OCN)(CH_3]_2$
Constants:
Mol. Wt. 264.3
Freezing P. 69.6°C
Density 1.197 at 80°/4°C
Toxicity: Details unknown, but probably an irritant.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

BLACK EBONY WOOD
Description: A wood.
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1
Acute Systemic: 0
Chronic Local: Allergen 1
Chronic Systemic: 0
Fire Hazard: Slight, in the form of dust when exposed to heat or flame; can react with oxidizing materials (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

BLACK POWDER. See Charcoal, Sulfur, Potassium Nitrate or Sodium Nitrate.
Shipping Regulations: Section 11.
I. C. C. Classification: Class A Explosive - Not Accepted.
Coast Guard Classification: Class A Explosive.

BLACK POWDER IGNITERS WITH EMPTY CARTRIDGE BAGS
See Explosives, Low.
Shipping Regulations: Section 11.
I. C. C. Classification: Class C Explosive.
Coast Guard Classification: Class C Explosive.

BLAST FURNACE GAS See Carbon Monoxide.

BLASTING CAPS, 1000 OR LESS
See Explosives, High.
Shipping Regulations: Section 11
I. C. C. Classification: Class C Explosive.
Coast Guard Classification: Class C Explosive

BLASTING CAPS, MORE THAN 1000. See Explosives, High
Shipping Regulations: Section 11.
I. C. C. Classification: Class A Explosive – Not Accepted.
Coast Guard Classification: Class A Explosive.

BLASTING CAPS WITH SAFETY FUSE, 1000 OR LESS CAPS
See Explosives, High.
Shipping Regulations: Section 11.
I. C. C. Classification: Class C Explosive.
Coast Guard Classification: Class C Explosive.

BLASTING GELATIN. See Explosives, High.
Synonym: SNG
Shipping Regulations: Section 11.

BLASTING POWDERS. See Explosives, Low.
Shipping Regulations: Section 11.
I. C. C. Classification: Class A Explosive - Not Accepted.
Coast Guard Classification: Class A Explosive.

BLAU GAS
Description: A gas.
Composition: Typical gas will analyze 51.9% illuminants; 0.1% carbon monoxide; 2.7% hydrogen; 44.1% methane, 1.2% nitrogen. etc.
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Inhalation2
Chronic Local: 0
Chronic Systemic: Inhalation 1
Fire Hazard: Dangerous, when exposed to flame (Section 6).
Explosion Hazard: Slight, when exposed to flame (Section 7).
Disaster Control: Moderately dangerous; shock can shatter the compressed gas container with explosive force; when heated, it burns and it can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

BLEACHING POWDER
Synonym: Chloride of lime.
Description: White powder.
Formula: $CaCl(ClO) \cdot 4H_2O$
Constant:
Mol. Wt. 199.0

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: U
- Chronic Local: Irritant 2
- Chronic Systemic: U

Fire Hazard: Moderate by chemical reaction with combustible materials (Section 6).
Caution: A powerful oxidizer. Deflagration occurs in contact with combustible substances.
Explosion Hazard: Moderate, in its solid form when heated (Section 7).
Explosive Range: When heated suddenly above 212°F.
Disaster Control: Dangerous, when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes and explodes; it will react with water or steam to produce toxic and corrosive fumes; it can react vigorously with reducing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
- Coast Guard Classification: Hazardous Material.

BLUE LEAD. See Lead Sulfate.

BLUE STONE. See Copper Sulfate.

BLUE VITRIOL. See Copper Sulfate.

BOILER COMPOUND LIQUID
Description: A caustic solution.
Toxicity: See Sodium Hydroxide.
Shipping Regulations: Section 11.
- I. C. C. Classification: Corrosive liquid; white label.
- Coast Guard Classification: Corrosive liquid; white label.

BOMBS, SAND-LOADED OR EMPTY See Explosives, High.
Shipping Regulations: Section 11.

BONE DUST
Composition: Phosphates and silicates of calcium, magnesium, etc.
Toxic Hazard Rating:
- Acute Local: Irritant 1; Inhalation 1
- Acute Systemic: 0
- Chronic Local: Irritant 1
- Chronic Systemic: Inhalation 1

MAC: ACGIH (accepted); 50 million particles per cubic foot or air. See also Nuisance Dusts.
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3

BOOSTERS (EXPLOSIVE). See Explosives, High.
Shipping Regulations: Section 11.
- I. C. C. Classification: Class A Explosive - Not Accepted.
- Coast Guard Classification: Class A Explosive.

BORAX
Synonyms: Tincal; tinkal.
Description: White gray, bluish or greenish white streak, vitreous or dull luster.
Formula: $Na_2B_4O_7 \cdot 10H_2O$
Constants:
- Mol. Wt. 381.44
- M. P. 75°C; $-8H_2O$ @60°C; $-10H_2O$ @200°C
- Density 1.69 - 1.72

Toxicity: See Boron Compounds.

BORAZOLE
Description: Colorless liquid.
Formula: $B_3N_3H_6$
Constants:
- Mol. Wt. 80.53
- M. P. −58°C
- B. P. 53°C
- Density 0.824 @0°C

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: U
- Chronic Local: Irritant 2
- Chronic Systemic: U

Fire Hazard: Dangerous by chemical reaction to produce flammable or even spontaneously flammable gases (Section 6).
Caution: Hydrolyzes in water to evolve boron hydrides.
Explosion Hazard: Details unknown. See also Boron Hydrides.
Disaster Control: Moderate; when heated to decomposition it emits toxic fumes; and upon reaction

with water it can evolve toxic and flammable gases.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1

BORDEAUX, ARSENITES, LIQUID. See Arsenic and Copper Compounds.
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

BORDEAUX, ARSENITES, SOLID. See Arsenic and Copper Compounds.
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

BORDEAUX MIXTURE. See Copper Compounds.

BORIC ACID
Synonyms: Boracic acid; o-boric acid.
Description: White crystals or powder.
Formula: H_3BO_3
Constants:
Mol. Wt. 61.84
M. P. 185°C (Decomp.) $-1\frac{1}{2}H_2O$ @ 300°C
Density 1.435 @15°C
Toxicity: See Boron Compounds.

BORIC ACID OINTMENT. See Boric Acid.

BORINE CARBONYL
Description: Colorless, unstable gas.
Formula: BH_3CO
Constants:
Mol. Wt. 41.85
M. P. −137.0°C
B. P. −64°C
Toxicity: See Carbon Monoxide, Boron Compounds and Boron Hydrides.
Fire Hazard: Dangerous, when exposed to heat or flame or by chemical reaction (Section 6). See also Boron Hydrides and Carbon Monoxide which are readily evolved by this material upon contact with heat or moisture.
Explosion Hazard: See Boron Hydrides and Carbon Monoxide.
Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes and it will react with water or steam to produce toxic and flammable vapors.
Storage and Handling: Section 7

BORINOAMINOBORINE
Description: Colorless liquid.
Formula: B_2H_7N
Constants:
Mol. Wt. 42.70
M. P. −66.5°C
B. P. 76.2°C
Vap. D. 14.7
Toxicity: See Boron Compounds.
Fire Hazard: It may evolve boron hydrides upon reaction with water or acids (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it can emit toxic and flammable decomposition products.

d-BORNEOL
Synonyms: alpha-camphanol; borneo camphor.
Description: Solid.
Formula: $C_{10}H_{17}OH$
Constants:
Mol. Wt. 154.24
M. P. 208°C
B. P. 212°C
Flash P. 302°F (C. C.)
Density 1.01 @20°/4°C
Vap. D. 5.31
Toxicity: Details unknown. See also Camphor.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing material.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BORNYL THIOCYANOACETATE
Synonym: Borneol thiocyanoacetate.
Description: Crystals.
Formula: $C_{10}H_{17}OOCCH_2CNS$
Constant:
Mol. Wt. 253.4

Toxicity: Unknown; an insectitide.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanide.
Storage and Handling: Section 7.

BOROCAINE
Synonym: Procaine borate.
Description: Crystals.
Formula: $C_{13}H_{20}N_2O_2 \cdot 5HBO_2$
Constants:
Mol. Wt. 455.5
M. P. 165 - 166°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2
Chronic Local: Irritant 1
Chronic Systemic: Ingestion 1; Inhalation 1; Skin Absorption 1
Fire Hazard: Slight, when heated, it emits toxic fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

BORON
Description: Monoclinic crystals, yellow or brown amorphous powder.
Formula: B
Constants:
At. Wt. 10.82
M. P. 2300°C
B. P. 2550°C
Density 3.33 @20°C
Toxicity: See Boron Compounds.
Fire Hazard: Moderate in the form of dust when exposed to air or by chemical reaction with oxidizing materials. See also Powdered Metals.
Explosion Hazard: An explosion hazard in the form of dust, which ignites on contact with air. See also Powdered Metals.
Storage and Handling: Section 7

BORON ACETATE
Synonym: Boric acetic anhydride.
Description: White to cream, hygroscopic crystals.
Formula: $(CH_3CO_2)_3B$
Constants:
Mol. Wt. 188.0
M. P. 135 - 144°C
Toxicity: See Boron Compounds and Acetic Acid.
Storage and Handling: Section 7

BORON BROMIDE DIIODIDE
Description: Colorless liquid.
Formula: $BBrI_2$
Constants:
Mol. Wt. 344.58
B. P. 180°C
Toxicity: See Boron Compounds, Bromides and Iodides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromides and iodides; it will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

BORON BROMIDE PENTAHYDRIDE
Description: Colorless gas.
Formula: B_2H_5Br
Constants:
Mol. Wt. 106.60
M. P. −104°C
B. P. 10°C (approx.)
Toxicity: See Boron Compounds and Bromides.
Fire Hazard: Details unknown; this material can evolve a boron hydride.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of boron hydrides; it will react with water or steam to produce toxic and corrosive fumes; it can react vigorously on contact with oxidizing materials.
Storage and Handling: Section 7

BORON CARBIDE
Description: Black crystals.
Formula: B_4C
Constants:
Mol. Wt. 55.29
M. P. 2450°C
B. P. > 3500°C
Density 2.50
Toxicity: See Nuisance Dusts.
Ventilation Control (use optional): Section 2

BORON CHLORIDE PENTAHYDRIDE
Description: Colorless gas, highly unstable.
Formula: B_2H_5Cl
Constants: Mol. Wt. 62.14
B. P. −78°C @18 mm
Toxicity: See Boron Compounds and Hydrochloric Acid.
Fire Hazard: See Boron Hydrides.

Explosion Hazard: See Boron Hydrides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of boron hydrides and hydrochloric acid; it will react with water or steam to produce toxic and corrosive fumes; can react vigorously with oxidizing material.
Storage and Handling: Section 7

BORON COMPOUNDS

Toxic Hazard Rating:
Acute Local: Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: 0
Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Toxicology: Not highly toxic and therefore not considered an industrial poison. Used in medicine as sodium borate, boric acid, or borax, which is also a common cleaner. Fatal poisoning of children has been caused in some instances by the accidental substitution of boric acid for powdered milk. The medical literature reveals many instances of accidental poisoning due to boric acid, oral ingestion of borates or boric acid, and presumably absorption of boric acid from wounds and burns. The fatal dose of orally ingested boric acid for an adult is somewhat more than 15 or 20 grams and for an infant 5 to 6 grams.

Boron is one of a group of elements, such as lead, manganese and arsenic, which affects the central nervous system. It is a cumulative poison and since its antiseptic value is weak, other more active and less harmful therapeutic agents should be employed for medicinal use. Boron poisoning causes depression of the circulation, persistent vomiting and diarrhea, followed by profound shock and coma. The temperature is subnormal and a scarletina-form rash may cover the entire body. Boric acid intoxication can come about from absorbing toxic quantities from ointments applied to burned areas or to wounds involving loss or damage to such areas of skin, but it is not absorbed from intact skin. When a 5% boric acid solution is used to irrigate body cavities most of the boric acid is absorbed by the tissues. Repeated doses can produce pathological changes in the central nervous system and kidneys.
Treatment and Antidotes: Large intravenous doses of isotonic salt solution and plasma have been shown to act as an antidote.

Care should be observed in applying ointments and dressings which contain boron over large areas of the body where the skin has been destroyed. It can be absorbed by the body in this way with the toxic effects noted above. Containers of boric acid should be plainly labelled and should be kept in containers which differ radically from those which contain powdered milk, particularly in institutions such as hospitals. The careless use of borax as a skin cleaner should be discouraged as well as the continuous irrigation of body cavities with solutions containing boron.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3

BORON DIBROMIDE IODIDE

Description: Colorless liquid.
Formula: BBr_2I
Constants:
Mol. Wt. 297.57
B. P. 125°C
Vap. D. 10.3
Toxicity: See Boron Compounds, Bromides and Iodides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromides and iodides; it will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

BORON FLUORIDE ETHERATE

See Boron Trifluoride Etherate.

BORON HYDRIDES. Diborane; dihydrotetraborane; pentaborane (stable);

pentaborane (unstable); hexaborane; decaborane.

Toxic Hazard Rating:
- Acute Local: Irritant 3; Inhalation 3
- Acute Systemic: Inhalation 3
- Chronic Local: Inhalation 3
- Chronic Systemic: Inhalation 3

MAC: ACGIH (tentative); 0.1 part per million in air.

Toxicology: Experimental studies in which dogs were exposed to diborane by inhalation resulted in severe irritation of the lungs and pulmonary edema. Similar observations have been reported in humans resulting at times in a reaction resembling metal fume fever. Human exposure to pentaborane has produced signs of severe central nervous system irritation such as drowsiness, dizziness, visual disturbances, muscle twitching and in severe cases painful muscle spasm.

Fire Hazard: Dangerous, when exposed to heat or flame or by chemical reaction. Pentaborane (stable) is spontaneously flammable in air. On contact with moisture, hydrogen is usually evolved (Section 6).

Explosion Hazard: Moderate, when exposed to heat or flame or by chemical reaction. Diborane reacts explosively with chlorine. Other boron hydrides evolve hydrogen upon contact with moisture or can propagate a flame rapidly enough to cause an explosion.

Disaster Hazard: Severe. Heat can cause these materials to decompose violently or at least to evolve hydrogen; they react with water or steam to evolve hydrogen. Powerful oxidizing agents such as chlorine gas, etc., can react violently with boron hydrides.

BORON NITRIDE

Description: Hexagonal, white crystals.

Formula: BN

Constants:
- Mol. Wt. 24.83
- M. P. 3000°C (sublimes)
- Density 2.20

Toxicity: Details unknown. This material is nearly insoluble and possibly therefore, a nuisance dust (See also Boron Compounds).

BORON OXIDE

Description: Vitreous, colorless crystals.

Formula: B_2O_3

Constants:
- Mol. Wt. 69.64
- M. P. 450°C (approx.)
- B. P. 1500°C
- Density 1.844

Toxicity: See Boron Compounds.

BORON PENTASULFIDE

Description: White crystals.

Formula: B_2S_5

Constants:
- Mol. Wt. 181.97
- M. P. 390°C
- Density 1.85

Toxicity: See Boron Compounds and Sulfides.

Fire Hazard: See Sulfides.

Disaster Control: See Sulfides.

Storage and Handling: Section 7

BORON PHOSPHATE

Description: A white powder.

Formula: BPO_4

Constants:
- Mol. Wt. 105.8
- M. P. > 1200°C
- Density 2.52

Toxicity: Probably merely a nuisance dust. See also Boron Compounds.

BORON PHOSPHIDE

Description: Maroon powder.

Formula: BP

Constants:
- Mol. Wt. 41.80
- M. P. Ign. 200°C

Toxicity: See Boron Compounds and Phosphides.

Fire Hazard: Ignites at 200°C. See also Phosphides.

Explosion Hazard: See Phosphides.

Disaster Control: See Phosphides.

Storage and Handling: Section 7

BORON TRIBROMIDE

Synonym: Boron bromide.

Description: Colorless, fuming liquid.

Formula: BBr_3

Constants:
Mol. Wt. 250.57
M. P. −45°C
B. P. 91.7°C
Density 2.650 @0°C
Vap. Press. 40 mm @14.0°C; 100 mm@ 33.5°C
Toxicity: See Boron Compounds and Hydrogen Bromide.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes of bromides and it will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

BORON TRICHLORIDE

Synonym: Boron chloride.
Description: Colorless, fuming liquid.
Formula: BCl_3
Constants:
Mol. Wt. 117.19
M. P. −107°C
B. P. 12.5°C
Density 1.434 @0°C
Vap. Press. 1 atm. @12.7°C
Vap. D. 4.03
Toxicity: See Boron Compounds and Hydrochloric Acid.
Disaster Control: Dangerous; as a result of shock the container can be shattered and toxic material released; when heated to decomposition, it emits toxic fumes of chlorides; it will react with water or steam to produce heat, toxic and corrosive fumes.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

BORON TRIETHYL

Synonyms: Boron ethyl; triethyl borine.
Description: Colorless liquid.
Formula: $B(C_2H_5)_3$
Constants:
Mol. Wt. 98.0
M. P. −93°C
B. P. 95°C
Density 0.6961 @23°C
Toxicity: Probably very toxic. See Boron Compounds.
Fire Hazard: Dangerous, by spontaneous chemical reaction with oxidizers (Section 6).
Caution: Spontaneously flammable in air.
Explosion Hazard: Unknown
Disaster Control: Highly dangerous, when heated to decomposition or upon contact with air it emits toxic fumes; it will react with water or steam to produce toxic and flammable vapors; it can react vigorously with oxidizing materials.
Storage and Handling: Section 7

BORON TRIFLUORIDE

Synonym: Boron fluoride.
Description: Colorless gas.
Formula: BF_3
Constants:
Mol. Wt. 67.82
M. P. −126.8°C
B. P. −110.7°C
Density 2.99 g/liter
Toxicity: See Boron Compounds and Fluorides.
Disaster Control: Moderately dangerous; shock can shatter the container; when heated to decomposition or upon contact with water or steam, it will produce toxic and corrosive fumes.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Nonflammable gas; green label.
Coast Guard Classification: Noninflammable gas; green gas label.

BORON TRIFLUORIDE ETHERATE

Composition: Boron trifluoride ether.
Toxicity: See Boron Compounds, Fluorides and Ether.
Fire Hazard: See Ether.
Explosion Hazard: See Ether.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of fluorides; it will react with water or steam to produce toxic, corrosive and flammable vapors; it can react vigorously with oxidizing materials.
Storage and Handling: Section 7

BORON TRIIODIDE

Description: Colorless, hygroscopic

plates.
Formula: BI_3
Constants:
Mol. Wt. 391.58
M. P. 43°C
B. P. 210°C
Density 3.35 @ 50°C
Toxicity: See Boron Compounds and Iodides.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits highly toxic fumes of iodides.
Storage and Handling: Section 7

BORON TRIMETHYL
Synonyms: Boron methyl; trimethyl borine.
Description: Colorless gas.
Formula: $B(CH_3)_3$
Constants:
Mol. Wt. 55.9
M. P. −161.5°C
B. P. −20°C
Density 1.91 g/liter (gas); 0.625 (solid @ −100°C)
Toxicity: Probably very toxic. See Boron Compounds.
Fire Hazard: Dangerous, when exposed to flame or by chemical reaction with oxidizing agents (Section 6).
Caution: Spontaneously flammable gas.
Explosion Hazard: Unknown.
Disaster Control: Highly dangerous; shock can shatter the container and release flammable and toxic vapors; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

BORON TRISELENIDE
Description: Yellow gray powder.
Formula: B_2Se_3
Constant:
Mol. Wt. 258.52
Toxicity: See Boron Compounds and Selenium Compounds.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

BORON TRISULFIDE
Description: White crystals.
Formula: B_2S_3
Constants:
Mol. Wt. 117.84
M. P. 310°C
Density 1.55
Toxicity: See Boron Compounds and Sulfides.
Fire Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

BOROPHOSPHORIC ACID
Description: White crystals.
Formula: $BPO_4 \cdot H_2O$
Constants:
Mol. Wt. 123.8
M. P. Decomposes
Density 1.873
Toxicity: See Boron Compounds and Phosphoric Acid.
Disaster Control: See Phosphates.
Storage and Handling: Section 7

BOROTUNGSTIC ACID
Description: Tetragonal, colorless crystals.
Formula: $H_5BW_{12}O_{40} \cdot 3OH_2O$
Constants:
Mol. Wt. 3403.39
M. P. 45 - 51°C
Density 3.0
Toxicity: See Boron Compounds and Tungsten Compounds.

BOX TOE GUM
Description: Liquid.
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

BOXWOOD
Description: A wood.
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 2
Acute Systemic: 0
Chronic Local: Allergen 2
Chronic Systemic: 0
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials (Section 6).

Personnel Protection: Section 3
Personal Hygiene: Section 3

BRASS (MASSIVE)
Description: Pale gold to red metal alloy.
Composition: Zn + Cu (mainly), Pb (small amounts), As, Sb, P, Sn, CN^- (traces).
Constants:
M. P. 940 - 1030°C
Density 8.40 - 8.75
Toxicity: See Brass Scrapings.

BRASS SCRAPINGS
Synonym: Brass powder.
Description: Finely divided particles of metal.
Composition: Zinc, copper (mainly), lead (minor constituent), arsenic, phosphorus, tin, antimony, cyanides (trace quantities).
Toxicity: See specific compound, particularly Zinc, Copper, Lead. Where quantities of brass scrapings can come in contact with acid or acid fumes, significant quantities of toxic fumes can be evolved. See Arsenic, Antimony, Phosphorus, Tin and Cyanides.
Fire Hazard: Moderate, when exposed to heat or flame. See also Powdered Metals.
Explosion Hazard: Slight, when exposed to flame. See also Powdered Metals.
Disaster Control: Moderately dangerous; when heated, it emits smoke; it can react with oxidizing materials, and on contact with acid or acid fumes, it can emit toxic fumes.
Storage and Handling: Section 7

BRAZIL NUT
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

BRAZIL WOOD
Synonyms: Redwood; pernambuco; fernambuco.
Description: A wood.
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

BRILLIANT CRESYL BLUE BB (L) 877
Description: A dye.
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

BRIMSTONE. See Sulfur.
Shipping Regulations: Section 11.
Coast Guard Classification: Hazardous article.

BROMACETYLENE. See Bromacetylene.

BROMATES
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2
Chronic Local: U
Chronic Systemic: Ingestion 2
Toxicology: Generally considered to be more toxic than chlorates, causing central nervous system paralysis. They may form methemoglobin, but less actively than chlorates. See also specific compounds as listed.
Fire Hazard: Moderate; in the form of gas, vapor or dust by chemical reaction with reducing agents (Section 6).
Caution: These are powerful oxidizing agents. They may react with oxidizable materials more or less violently, very often causing combustion.
Disaster Control: Dangerous; when heated to decomposition, they emit toxic fumes of bromine and they can react with reducing

material.
Personal Hygiene: Section 3
Storage and Handling: Section 7

BROMIC ACID

Description: Colorless or slightly yellow liquid; turns yellow on exposure.
Formula: $HBrO_3$
Constants:
  Mol. Wt. 128.92
  M. P. Decomposes 100°C
  Density 3.1883
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: Irritant 2
  Chronic Systemic: U
Fire Hazard: See Bromates.
Disaster Control: See Bromates.
Ventilation Control: Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

BROMIDES

Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 2; Inhalation 2
  Acute Systemic: Ingestion 2
  Chronic Local: Irritant 1
  Chronic Systemic: Ingestion 2; Inhalation 2
Toxicology: The most common inorganic bromides are sodium, potassium, ammonium, calcium and magnesium bromides. Methyl and ethyl bromides are among the most common organic bromides.

The inorganic bromides produce depression, emaciation and in severe cases, psychoses and mental deterioration. Bromide rashes (bromoderma) especially of the face, and resembling acne and furunculosis often occur when bromide inhalation or administration is prolonged.

Organic bromides, such as methyl bromide and ethyl bromide, are volatile liquids of relatively high toxicity. See also specific compounds.

Disaster Control: When strongly heated, they emit highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3

BROMINE

Description: Rhombic crystals or dark-red liquid.
Formula: Br_2
Constants:
  Mol. Wt. 159.83
  Freezing P. −7.3°C
  B. P. 58.73°C
  Density 2.928 @59°C; 3.12 @20°C
  Vap. Press. 175 mm @21°C; 1 atm. @58.2°C
  Vap. D. 5.5
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: Irritant 2
  Chronic Systemic: Ingestion 2; Inhalation 2
MAC: ACGIH (accepted): 6.5 milligrams per cubic meter of air; 1 part per million in air.
Toxicology: The action of bromine is essentially the same as that of chlorine, being an irritant to the mucous membranes of the eyes and upper respiratory tract. Severe exposures may result in pulmonary edema. Usually, however, the irritating qualities of the chemical force the workman to leave the exposure before serious poisoning can result. Chronic exposure similar to therapeutic ingestion of excessive bromides. See also Bromides. Regular physical examinations should be made of people who work with bromine.
Radiation Hazard (Section 5): Artificial isotope Br^{82}, half-life: 35.5 hours; emits many gamma rays of 0.07-1.7 mev and other radiation of 0.47 mev (e^-) and −mev (k).
Fire Hazard: Moderate; in the form of liquid or vapor by spontaneous chemical reaction with reducing materials (Section 6).
Caution: May ignite a combustible material upon contact. A very powerful oxidizer.
Disaster Control: Highly dangerous; heat and shock can shatter the container and release toxic fumes; when heated

it emits highly toxic fumes; it will react with water or steam to produce toxic and corrosive fumes; and it can react vigorously with reducing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

BROMINE AZIDE
Synonym: Bromoazide.
Description: Crystals or red liquid.
Formula: BrN_3
Constants:
Mol. Wt. 121.94
M. P. 45°C (approx.)
B. P. Explodes
Toxicity: See Bromine and Azides.
Fire Hazard: Moderate, in the form of vapor by chemical reaction (Section 6).
Caution: A powerful oxidant. See also Bromine.
Explosion Hazard: Moderate, when exposed to heat (Section 7).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromine and explodes; it will react with water or steam to produce toxic and corrosive fumes and it can react on contact with reducing materials.
Storage and Handling: Section 7

BROMINE CHLORIDE
Description: Reddish-yellow liquid or gas.
Formula: BrCl
Constants:
Mol. Wt. 115.37
B. P. Decomposes 10°C
Toxicity: See Bromine, Chlorine.
Fire Hazard: Moderate, in the form of vapor by spontaneous chemical reaction.
Caution: A powerful oxidant. See also Bromine.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of bromine and chlorine; it will react with water or steam to produce toxic and corrosive fumes and on contact with reducing material, it can react vigorously.
Storage and Handling: Section 7

BROMINE DIOXIDE
Description: Light-yellow crystals.
Formula: BrO_2
Constants:
Mol. Wt. 111.92
M. P. 0°C (Decomp.)
Toxicity: See Bromine.
Fire Hazard: Moderate, in the form of vapor by chemical reaction with reducing agents (Section 6).
Caution: A strong oxidant.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of bromine and will react with water or steam to produce toxic and corrosive fumes; can react vigorously with reducing materials.
Storage and Handling: Section 7

BROMINE HYDRATE
Description: Red crystals.
Formula: $Br_2 \cdot 10H_2O$
Constants:
Mol. Wt. 340.0
M. P. 6.8°C (Decomp.)
Toxicity: See Bromine.
Fire Hazard: Moderate, in the form of vapor by chemical reaction with reducing materials (Section 6).
Caution: A strong oxidant.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromine and on contact with water or steam, it will react to produce toxic and corrosive fumes; can react vigorously with reducing materials.
Storage and Handling: Section 7

BROMINE MONOXIDE
Description: Dark-brown crystals.
Formula: Br_2O
Constants:
Mol. Wt. 175.83
M. P. −17 to −18°C (Decomp.)
Toxicity: See Bromine.
Fire Hazard: Moderate, by chemical reaction with reducing agents (Section 6).
Caution: A strong oxidant.
Disaster Control: Dangerous; when

heated to decomposition it emits highly toxic fumes of bromine; it will react with water or steam to produce toxic and corrosive fumes; can react vigorously with reducing materials.
Storage and Handling: Section 7

BROMINE OCT-OXIDE
Description: White crystals.
Formula: Br_3O_8
Constants:
  Mol. Wt. 367.75
  M. P. Stable at −40°C
Toxicity: See Bromine.
Fire Hazard: Moderate, upon contact with reducing agents (Section 6).
Caution: A strong oxidant.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of bromine; it will react with water or steam to produce toxic and corrosive fumes; can react vigorously with reducing materials.
Storage and Handling: Section 7

BROMINE PENTAFLUORIDE
Description: Colorless liquid.
Formula: BrF_5
Constants:
  Mol. Wt. 174.92
  M. P. −61.3°C
  B. P. 40.5°C
  Density 2.466 @25°C
  Vap. D. 6.05
Toxicity: See Bromine and Fluorides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of bromine and fluorine; it will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Corrosive liquid; white label.
  Coast Guard Classification: Corrosive liquid; white label.

BROMINE TRIFLUORIDE
Description: Colorless, gray-yellow liquid.
Formula: BrF_3
Constants:
  Mol. Wt. 136.92
  M. P. 8.8°C
  B. P. 135°C
  Density 2.49 @135°C
Toxicity: See Bromine and Fluorides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of bromine and fluorine; it will react with water or steam to produce heat, toxic and corrosive fumes.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Corrosive liquid; white label.
  Coast Guard Classification: Corrosive liquid; white label.

N-BROMOACETAMIDE
Synonym: NBA
Description: White powder, odor similar to bromine.
Formula: $CH_3CONHBr$
Constants:
  Mol. Wt. 138.0
  M. P. 105 - 108°C
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromine.
Storage and Handling: Section 7

BROMOACETONE
Description: Colorless liquid when pure; pungent odor.
Formula: $CH_2BrCOCH_3$
Constants:
  Mol. Wt. 136.99
  M. P. −54°C
  B. P. 136°C
  Density 1.631 @0°C
Toxicity: Details unknown. Probably toxic.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of bromides.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Poison A; poison gas label, not accepted.
  Coast Guard Classification: Poison A; poison gas label.

BROMOACETOPHENONE
Synonym: Phenacyl bromide.
Description: White rhombic prisms changing to greenish color under the influence of light.
Formula: $BrCH_2COC_6H_5$

Constants:
Mol. Wt. 199.05
M. P. 50°C
B. P. 140°C @12 mm
Density 1.647 @20°/4°C
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of bromides.
Storage and Handling: Section 7

BROMOACETYLENE
Synonym: Bromoethyne
Description: Gas.
Formula: CHCBr
Constants:
Mol. Wt. 104.9
B. P. -2°C
Vapor Density 4.684
Toxicity: Unknown
Fire Hazard: Dangerous, by spontaneous chemical reaction (Section 6).
Caution: A spontaneously flammable gas.
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it burns and emits toxic fumes; it can react with oxidizing materials.
Storage and Handling: Section 7

BROMOANILINE
Synonym: o-Bromoaniline.
Description: Crystals.
Formula: $BrC_6H_4NH_2$
Constants:
Mol. Wt. 172.0
M. P. 32°C
B. P. 229°C
Toxicity: Details unknown. See also Aniline.
Disaster Control: Moderately dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits toxic fumes.
Storage and Handling: Section 7

BROMOAURIC ACID
Description: Red-brown crystals.
Formula: $HAuBr_4 \cdot 5H_2O$
Constants:
Mol. Wt. 607.95
M. P. 27°C
Toxicity: See Bromides and Gold Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromine.
Storage and Handling: Section 7

p-BROMOAZOBENZENE
Formula: $BrC_6H_4NNC_6H_5$
Constant:
Mol. Wt. 261.1
Toxicity: Unknown; an insecticide.
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes of bromides.
Storage and Handling: Section 7

BROMOBENZENE
Synonym: Phenyl bromide.
Description: Clear, colorless, mobile liquid.
Formula: C_6H_5Br
Constants:
Mol. Wt. 157.02
M. P. -30.7°C
B. P. 156.2°C
Flash P. 149°F (C.C.)
Density 1.497
Vap. Press. 10 mm @40.0°C
Vap. D. 5.41
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: Ingestion 1; Inhalation 1
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical, or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes; it can react with oxidizing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Inflammable liquid.

p-BROMOBENZONITRILE
Description: Crystals.
Formula: BrC_6H_4CN
Constants: Mol. Wt. 182
M. P. 113°C
Toxicity: An insecticide. See also Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

BROMOBENZYL CYANIDE
Synonym: o-Bromo-2-phenylacetonitrile; BBC

Description: (pure) yellowish-white crystals; (tech) brown, oily liquid; pungent odor of soured fruit.
Formula $C_6H_4CH_2CNBr$
Constants:
Mol. Wt. 196.1
M. P. 29°C
B. P. 242°C
Freezing P. 25.5°C
Density 1.5160 @20°C
Flash P. None
Vap. D. 6.8
Vap. Press. 0.011 mm @20°C
Toxicity: See Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Poison C; tear gas label.
Coast Guard Classification: Poison C; tear gas label.

o-BROMOBENZYL CYANIDE. See Bromobenzyl Cyanide

2-BROMO-4-tert-BUTYL PHENOL
Description: Straw-colored liquid.
Formula: $(CH_3)_3CC_6H_3BrOH$
Constants:
Mol. Wt. 229.1
B. P. 104 - 105°C @5 mm
Flash P. 240°F
Freezing P. < -20°C
Density 1.319 @25°/25°C
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; it can react with oxidizing materials.
Storage and Handling: Section 7

1-BROMO-4-CHLOROBENZENE
Description: White crystals.
Formula: C_6H_4BrCl
Constants: Mol. Wt. 191.5
M. P. 67.4°C
B. P. 196.3°C
Freezing P. 64.5°C
Toxicity: Unknown.
Disaster Control: Moderately dangerous; when heated, it emits toxic fumes.
Storage and Handling: Section 7

BROMOCUMENE. See Bromoisopropyl Benzene.

BROMOCYCLOHEXANE
Description: Yellowish liquid.
Formula: $C_6H_{11}Br$
Constants:
Mol. Wt. 163.1
B. P. 165.8 - 167.3°C
Flash P. 145°F
Density 1.337
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes; it can react with oxidizing materials.
Storage and Handling: Section 7

BROMODICHLOROMETHANE
Description: Colorless liquid.
Formula: $CHBrCl_2$
Constants:
Mol. Wt. 163.8
B. P. 89.2 - 90.6°C
Density 1.971 @25°/25°C
Toxicity: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes.
Storage and Handling: Section 7

3-BROMO-5, 5-DIMETHYLHYDANTOIN
Description: White to buff powder; mild odor but like bromine.
Formula: $C_5H_7N_2O_2Br$
Constant:
Mol. Wt. 207.03
Toxicity: Unknown.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of bromine and bromides.
Storage and Handling: Section 7

4-BROMODIPHENYL
Description: White crystals.
Formula: $C_6H_5C_6H_4Br$
Constants:
Mol. Wt. 233.1
M. P. 89.8 - 90.3°C
B. P. 310.8°C
Flash P. 290°F

Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes; it can react with oxidizing materials.
Storage and Handling: Section 7

BROMOETHANE. See Methyl Bromide.

2-BROMOETHYL ACETATE
Formula: $BrC_2H_4O_2C_2H$
Constant:
Mol. Wt. 165
Toxicity: See Esters.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits highly toxic fumes of bromine and bromides.
Storage and Handling: Section 7

BROMOETHYLBENZENE
Description: Colorless to pale-yellow liquid.
Formula: $BrC_6H_4CH_2CH_3$
Constants:
Mol. Wt. 185.1
M. P. -65°C
B. P. 201°C
Density 1.35-1.4 @ 25°/25°C
Flash P. 205°F
Vap. D. 6.4
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes of bromides, etc.; it can react with oxidizing materials.
Storage and Handling: Section 7

BROMOETHYL CHLOROSULFONATE
Description: Liquid.
Formula: $BrCH_2CH_2OSO_2Cl$
Constants:
Mol. Wt. 223.49
B. P. 100 to 105°C @ 18 mm
Toxic Hazard Rating:
Acute Local: Irritant 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits toxic fumes of oxides of sulfur and bromides; it will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-BROMOETHYL ETHYL ETHER
Description: Liquid.
Formula: $BrCH_2CH_2OCH_2CH_3$
Constants:
Mol. Wt. 153
Vap. D. 5.25
Toxicity: Unknown; an insecticide. See also Ethers.
Fire Hazard: See Ethers.
Explosion Hazard: See Ethers.
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes of bromides; it can react vigorously with oxidizing materials.
Storage and Handling: Section 7

BROMOFORM
Synonym: Tribromomethane.
Description: Colorless liquid or hexagonal crystals.
Formula: $CHBr_3$
Constants:
Mol. Wt. 252.77
M. P. 6 - 7°C
B. P. 149.5°C
Flash P. None
Density 2.890 @ 20°/4°C
Toxic Hazard Rating:
Acute Local: Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: Irritant 2
Chronic Systemic: Ingestion 2; Inhalation 2
Toxicology: This material causes lachrymation. It can damage the liver to a serious degree and

cause death. It has been said that its medicinal application has resulted in numerous poisonings. It has anesthetic properities similar to those of chloroform, but it is not sufficiently volatile for inhalation purposes and is far too toxic to be recommended. In addition to its narcotic effects, it is a metabolic poison. Petroleum geologists working in closed rooms with a large number of funnels or open separatory flasks, as required for routine procedure in the separation of minerals, can be subjected to appreciable concentrations of bromoform as an atmospheric contaminant. The inhalation of small amounts of this material causes irritation, provoking the flow of tears and saliva and reddening of the face. In dogs, 29,000 ppm caused a deep narcosis after 8 minutes, and death after 1 hour; in 30 minutes there was deep narcosis and recovery on the next day.

Treatment and Antidotes: Remove patient to fresh air and if breathing has stopped administer artificial respiration. Give oxygen if necessary. Call a physician.

Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

BROMOGERMANE

Description: Colorless liquid.

Formula: GeH_3Br

Constants:
- Mol. Wt. 155.54
- M. P. -32.0°C
- B. P. 52.0°C
- Density 2.34 @ 29.5°C

Toxicity: See Germanium Compounds and Bromides.

Fire Hazard: Moderate, when exposed to heat or flame (Section 6).

Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of bromine; it can react vigorously with oxidizing materials.

Storage and Handling: Section 7

p-BROMOHYDROAZOBENZENE

Toxicity: Unknown; an insecticide.

Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes of bromides.

Storage and Handling: Section 7

BROMOISOPROPYL BENZENE

Synonym: ar-Bromo cumene.

Description: Colorless liquid.

Formula: $BrC_6H_4CH(CH_3)_2$

Constants:
- Mol. Wt. 199.1
- M. P. -20°C
- B. P. 212 - 216°C
- Flash P. 207°F
- Density 1.27-1.3 @ 25°/25°C
- Vap. D. 6.90

Toxicity: Unknown

Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.

To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

BROMO METHYLETHYL KETONE

Description: Colorless to pale-yellowish liquid.

Formula: $BrCH_2COC_2H_5$

Constants:
- Mol. Wt. 135.01
- B. P. 145 - 146°C Decomposes
- Density 1.43

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Disaster Control. Moderately dangerous; when heated to decomposition it emits toxic fumes of bromides; it can react with oxidizing materials.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

1-BROMO-3-NITROBENZENE

Description: Crystals.

Formula: $BrC_6H_4NO_2$

Constants: Mol. Wt. 202.0
- M. P. 56°C
- B. P. 256.5°C
- Density 1.70 @ 20°/4°C

Toxicity: Details unknown. See also Nitrobenzene.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen and bromides; it can react vigorously with oxidizing materials.
Storage and Handling: Section 7

2-BROMO-4-PHENYLPHENOL
Description: Crystals.
Formula: $BrC_6H_5OC_6H_5OH(C_{12}H_9BrO)$
Constants: Mol. Wt. 267.1
M. P. 95°C
B. P. 195°C decomp.
Flash P. 405°F
Vap. Press. 1 mm @100.0°C
Toxicity: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits toxic fumes.
Storage and Handling: Section 7

BROMOPICRIN
Synonyms: Nitrobromoform; tribromonitromethane.
Description: Prismatic crystals.
Formula: CBr_3NO_2
Constants:
Mol. Wt. 297.77
M. P. 103°C
B. P. 127°C
Density 2.79 @18°C
Toxicity: Irritant!
Fire Hazard: Unknown
Explosion Hazard: Severe, when heated rapidly (Section 7).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of nitrogen and bromides and explodes.
Storage and Handling: Section 7

BROMOPLATINIC ACID
Description: Monoclinic, deliquescent red crystals.
Formula: $H_2PtBr \cdot 9H_2O$
Constants:
Mol. Wt. 838.9
M. P. < 100°C Decomposes
Toxicity: See Bromides and Platinum Compounds.
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes of bromides.
Storage and Handling: Section 7

BROMOSUCCINIMIDE
Description: White to pale buff, fine crystalline powder with faint odor of bromine.
Formula: $C_4H_4O_2NBr$
Constants:
Mol. Wt. 178.0
M. P. 174 - 178°C
Density 2.098
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Caution: A powerful irritant.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

o-BROMOTOLUENE
Description: Colorless liquid.
Formula: $CH_3C_6H_4Br$
Constants:
Mol. Wt. 171.0
B. P. 180 - 182°C
Freezing P. −27°C
Flash P. 175°F
Density 1.422 @25°/25°C
Toxicity: Unknown
Fire Hazard: Moderate; when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

p-BROMOTOLUENE
Description: White crystals.
Formula: $CH_3C_6H_4Br$
Constants:
Mol. Wt. 171.0
B. P. 183.3 - 184.1°C
Freezing P. 25.5°C
Flash P. 185°F
Density 1.400 @27°/25°C
Toxicity: Unknown

Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; it can react with oxidizing materials.
Storage and Handling: Section 7

BROMOTRICHLOROMETHANE
Description: Colorless liquid.
Formula: $CBrCl_3$
Constants:
  Mol. Wt. 198.3
  B. P. 103.8 - 105.1°C
  Density 1.997 @25°/25°C
Toxicity: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes.
Storage and Handling: Section 7

BRONZE. See Copper and Tin and Zinc.

BRONZE LIQUID PAINT
Composition: Liquid vehicle and bronze.
Constant:
  Flash P. Below 100°F
Toxicity: See specific vehicle employed.
Fire Hazard: Dangerous, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown.
Explosive Range: Depends upon components used.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  See also Paint, Enamel, Lacquer, Stain, Shellac, Varnish, etc.
  Coast Guard Classification: Inflammable liquid; red label.

BRUCINE
Description: Monoclinic prisms.
Formula: $C_{23}H_{26}N_2O_4$
Constants:
  Mol. Wt. 394.45
  M. P. 178°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: U
Caution: An alkaloid like strychnine but $\frac{1}{6}$ as toxic.
Disaster Control: Dangerous; when heated, it emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.

BRUCINE COMPOUNDS. See Brucine.

BRUCINE NITRATE
Description: White powder.
Formula:
  $C_{23}H_{26}N_2O_4 \cdot HNO_3 \cdot 2H_2O$
Constants:
  Mol. Wt. 493.51
  M. P. Anh. 230°C Decomposes
Toxicity: See Brucine.
Fire Hazard: Moderate by chemical reaction with reducing agents (Section 6).
Caution: A powerful oxidant.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

BURNT COTTON (NOT REPICKED)
Toxicity: Unknown
Fire Hazard: Moderate when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid; yellow label.

BURNT FIBER
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame or powerful oxidizers (Section 6).
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid; yellow label.

BURWEED MARSH ELDER

Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: 0
  Chronic Local: Allergen 1
  Chronic Systemic: 0
Fire Hazard: Slight, when exposed to heat or flame.
Personal Hygiene: Section 3
Storage and Handling: Section 7

BUTADIENE-1, 3

Synonyms: Methylallene; erythrene.
Description: Colorless gas.
Formula: CH_2CCHCH_3
Constants:
  Mol. Wt. 54.09
  B. P. -4.5°C
  Freezing P. -108.9°C
  Flash P. < 20°F
  Density 0.621 @ 20°/4°C
  Autoign. Temp. 842°F
  Vap. D. 1.87
  Vap. Press. 1840 mm @ 21°C
Toxic Hazard Rating:
  Acute Local: Irritant 1; Inhalation 1
  Acute Systemic: Inhalation 1
  Chronic Local: U
  Chronic Systemic: Inhalation 1
MAC: ACGIH (accepted); 1000 parts per million in air; 2210 milligrams per cubic meter of air.
Fire Hazard: Dangerous, when exposed to heat, flame or powerful oxidizers.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or water spray (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame; may form explosive peroxides upon exposure to air.
Explosive Range: 2.0 - 11.5%
Disaster Control: Moderately dangerous; shock can shatter the compressed gas container; when heated, it emits acrid fumes; can react with oxidizing materials.
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: red label.

BUTADIENE, INHIBITED. See Butadiene.

Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable gas; red gas label.
  Coast Guard Classification: Inflammable gas; red gas label.

BUTADIENE MONOXIDE

Synonym: Vinylethylene oxide.
Description: Liquid.
Formula: $CH_3(CH_2)_2CH_3$
Constants:
  Mol. Wt. 58.12
  M. P. -135°C
  B. P. 151°F
  Flash P. < -58°F (C. C.)
  Density 0.869
  Autoign. Temp. 806°F
  Vap. D. 2.41
Toxicity: See Butadiene.
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical, carbon tetrachloride or water spray (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition it emits acrid fumes; it can react with oxidizing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11

BUTANE

Synonyms: n-Butane; methylethylmethane; butyl hydride.
Description: Colorless gas.
Formula:
  $CH_3CH_2CH_2CH_3$
Constants:
  Mol. Wt. 58.1
  B. P. -0.5°C
  Freezing P. -138.6°C
  Flash P. -76°F (C. C.)
  Density 0.599
  Autoign. Temp. 806°F
  Vap. Press. 2 atm. @ 18.8°C
  Vap. D. 2.046
Toxic Hazard Rating:
  Acute Local: 0
  Acute Systemic: Inhalation 2
  Chronic Local: U
  Chronic Systemic: Inhalation 1
Caution: Produces drowsiness. Simple asphyxiant.
Fire Hazard: Dangerous; when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or water spray (Section 6).

Spontaneous Heating: No
Explosion Hazard: Moderate, when exposed to flame (Section 7).
Explosive Range: 1.6 - 6.5%
Disaster Control: Moderately dangerous; shock can shatter the compressed gas container; when heated it emits acrid fumes; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11
I.C.C. Classification: Flammable gas; red gas label.

1,4-BUTANEDIOL

Synonym: Butanediol.
Description: Nearly odorless, colorless, viscid liquid.
Formula: $HOCH_2CH_2CH_2CH_2OH$
Constants:
Mol. Wt. 90.1
B. P. 228°C
Freezing P. 20.9°C
Flash P. > 250°F (O.C.)
Density 1.0154 @ 25°/4°C
Vap. D. 3.1
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride.
Personal Hygiene: Section 3
Storage and Handling: Section 7

BUTANEDIOL DICAPRYLATE

Description: A clear liquid.
Formula: $(CH_2)_2(CH_2OCOC_7H_{15})_2$
Constant:
Mol. Wt. 342
B. P. 220°C @ 5 mm
Freezing P. 10.5°C
Flash P. 390°F
Density 0.929 @ 20°/20°C
Vap. D. 11
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

1,2,4-BUTANETRIOL

Synonym: Butanetriol.
Description: Colorless, nearly odorless, thick liquid.
Formula: $HOCH_2CHOHCH_2CH_2OH$
Constants:
Mol. Wt. 106.1
B. P. 312°C
Freezing P. Supercools
Flash P. 332°F (C.O.C.)
Density 1.184 @ 4°C
Toxicity: Practically nontoxic. Resembles glycerine.

BUTANOL. See Butyl Alcohol.

BUTANONE

Synonym: Methylethyl ketone.
Description: Colorless liquid, acetone-like odor.
Formula: $CH_3COCH_2CH_3$
Constants:
Mol. Wt. 72.10
B. P. 79.57°C
Freezing P. -85.9°C
Flash P. 22°F (T.O.C.)
Density 0.80615 @ 20°/20°C
Vap. Press. 71.2 mm @ 20°C
Autoign. Temp. 960°F
Vap. D. 2.41
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: Inhalation 2
Chronic Local: Irritant 1
Chronic Systemic: U
MAC: ACGIH (accepted): 250 parts per million in air; 735 milligrams per cubic meter of air.
Fire Hazard: Dangerous, when exposed to heat or flame; it can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame (Section 7).
Explosive Range: 1.81 - 11.5%
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

1-BUTENE. See Butylene.

cis-BUTENE-2

Synonyms: Dimethylehtylene;

pseudo-butylene.
Description: Colorless gas.
Formula: $CH_3CHCHCH_3$
Constants:
Mol. Wt. 56.1
B. P. 1°C
Freezing P. −139°C
Flash P. < 20°F
Density 0.627 @15.5°/15.5°C
Vap. Press. 1410 mm @21°C
Toxicity: Details unknown. May act as a simple asphyxiant.
Fire Hazard: Dangerous, when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use optional): Section 2
Storage and Handling: Section 7

trans-**BUTENE**-2
Description: A gas.
Formula: C_4H_8
Constants:
Mol. Wt. 56.1
B. P. 2.5°C
Freezing P. −105.6°C
Flash P. < 20°F
Density 0.613 @15.5°/15.5°C
Vap. D. 1.95
Vap. Press. 1592 mm @21°C
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7

2-**BUTENE**-1,4-**DIOL**
Description: Colorless, odorless liquid.
Formula: $NOCH_2CHCHCH_2OH$
Constants:
Mol. Wt. 88.1
B. P. 234°C
Freezing P. 12.5°C
Flash P. 263°F (C.O.C.)
Density 1.07 @25°/15°C
Vap. D. 3.04
Toxicity: Unknown
Caution: This material is an irritant to the skin.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

3-**BUTENE**-2-**ONE**. See Methyl Vinyl Ketone.

2-**BUTEN**-1-**OL**. See alpha-Methallyl Alcohol.

BUTESIN
Synonym: Butyl-p-aminobenzoate.
Description: Yellow, amorphous powder.
Formula: $C_6H_4NH_2COOC_4H_9$
Constants: Mol. Wt. 193.24
M. P. 55°C
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; on decomposition it emits toxic fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

BUTESIN PICRATE OINTMENT
Description: A yellow ointment.
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Caution: Has been known to cause dermatitis (Section 9).
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen.
Personal Hygiene: Section 3
Storage and Handling: Section 7

BUTOPYRONOXYL
Synonym: Butyl mesityl oxide.
Description: Yellow to reddish liquid.
Formula: $C_{12}H_{18}O_4$
Constants:
Mol. Wt. 226.3
B. P. 256 - 270°C
Density 1.052 - 1.060 @25°/25°C
Toxicity: Unknown
Fire Hazard: Slightly dangerous; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

BUTOXYETHYL ACRYLATE
Description: Liquid.
Formula: $CH_2CHCO_2CH_2CH_2OC_4H_9$
Constants:
Mol. Wt. 172.2
B. P. 62°C @2 mm
Flash P. 185°F (O.C.)
Density 0.948 @20°C
Vap. D. 5.93
Toxicity: See Esters, and Ethyl Acrylate.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTOXYETHYL STEARATE
Description: Light-colored liquid with mild odor.
Formula: $CH_3(CH_2)_{16}COOC_2H_4OC_4H_9$
Constants:
Mol. Wt. 384
M. P. 10 - 16°C
B. P. 215 - 245°C @4 mm
Flash P. 420°F
Density 0.882 @20°/20°C
Vap. Press. 0.03 mm @ 150°C
Vap. D. 13.2
Toxicity: See Esters.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTOXYL
Description: Bitter taste, somewhat acid odor.
Formula:
$CH_3CH(OCH_3)CH_2CH_2OCOCH_3$
Constants: Mol. Wt. 134
B. P. 135 - 171°C
Flash P. 170°F
Toxicity: Details unknown. See Glycols.
Fire Hazard: Moderate; when heated it emits acrid fumes (Section 6).
Storage and Handling: Section 7

beta-BUTOXY-beta-THIOCYANODIETHYL ETHER
Toxicity: See Thiocyanates.
Fire Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides.
Storage and Handling: Section 7

BUTYL ACETAMIDE
Description: Liquid.
Formula: $CH_3CONHC_4H_9$
Constants:
Mol. Wt. 117.2
B. P. 455°F
Flash P. 240°F
Density 0.89
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

BUTYLACETANILIDE
Description: Slightly yellow liquid.
Formula: $CH_3(CH_2)_3N(C_6H_5)C(O)CH_3$
Constants:
Mol. Wt. 191.3
M. P. 20.8°C
B. P. 277 - 281°C
Flash P. 286°F
Density 0.992 @25°/25°C
Vap. D. 6.6
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL ACETATE
Synonym: Butyl ethanoate.
Description: Colorless liquid.
Formula: $CH_3COOC_4H_9$
Constants:
Mol. Wt. 116.16
B. P. 126°C
Freezing P. −73.5°C
Flash P. 92°F (T.O.C.)
Density 0.88 @20°/20°C
Autoign. Temp. 790°F
Vap. D. 0.88
Vap. Press. 15 mm @25°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1; Ingestion 2; Inhalation 0
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: Allergen 1

Chronic Systemic: Inhalation 1
Skin Absorption 1
MAC: ACGIH (accepted); 200 parts per million in air; 948 milligrams per cubic meter of air. See also Esters, n-butyl Alcohol and Acetic Acid.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
Underwriters Laboratory Classification: 50-60
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame (Section 7).
Explosive Range: 1.7 - 15%
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Inflammable liquid.

sec-BUTYL ACETATE

Synonyms: Aceticacid secondary butyl ester; 2-butanol acetate.
Description: Colorless liquid; mild odor.
Formula: $CH_3COOC_4H_9$
Constants:
Mol. Wt. 116.1
B. P. 112°C
Flash P. 66°F (C.C.)
Density 0.862-0.866 @20°/20°C
Vap. D. 4.00
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1; Ingestion 2; Inhalation 0
Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 1
Chronic Local: Allergen 1
Chronic Systemic: Ingestion 1; Inhalation 1; Skin Absorption 1
Fire Hazard: Dangerous, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame (Section 7).
Explosive Range: 1.7% (L.E.L.)
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11

BUTYL ACETOACETATE

Description: Liquid.
Formula:
$CH_3COCH_2COOCH_2CH_2CH_2CH_3$
Constants: Mol. Wt. 160.2
B. P. 417°F
Flash P. 185°F
Density 0.96
Vap. D. 5.55
Toxicity: Details unknown. See Esters, Acetoacetic Acid and Butyl Alcohol.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL ACETYL RICINOLEATE

Description: Yellow, oily liquid.
Formula: $C_{18}H_{33}O_3C_4H_8CH_3CO$
Constants:
Mol. Wt. 396.6
M. P. -25°F
B. P. 428°F
Flash P. 230°F (O.C.)
Density 0.940
Autoign. Temp. 725°F
Vap. D. 13.7
Toxicity: Details unknown. See Esters.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

n-tert-BUTYLACRYLAMIDE

Description: White, crystalline solid.
Formula: $C_7H_{13}ON$
Constants:
Mol. Wt. 127.18
M. P. 128 - 130°C with polymerization
Density 1.015 @30°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U

Fire Hazard: Slight; on decomposition it emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

BUTYL ACRYLATE

Description: Water-white extremely reactive monomer.
Formula: $C_7H_{12}O_2$
Constants:
  Mol. Wt. 128.2
  B. P. 69°C @ 50 mm
  Freezing P. −64.6°C
  Flash P. 120°F (O.C.)
  Density 0.894 @ 25°/25°C
  Vap. Press. 10 mm @ 35.5°C
  Vap. D. 4.42
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2
  Acute Systemic: Ingestion 2
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

BUTYL ALCOHOL

Synonym: n-Butanol.
Description: Colorless liquid.
Formula: $CH_3(CH_2)_2CH_2OH$
Constants:
  Mol. Wt. 74.12
  B. P. 117.5°C
  Freezing P. −88.9°C
  Flash P. 114°F (T.O.C.)
  Density 0.80978 @ 20°/4°C
  Autoign. Temp. 650°F
  Vap. Press. 5.5 mm @ 20°C
  Vap. D. 2.55
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 2
  Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
  Chronic Local: U
  Chronic Systemic: Ingestion 1; Inhalation 1; Skin Absorption 1
MAC: ACGIH (accepted); 100 parts per million in air; 303 milligrams per cubic meter of air.
Toxicology: Though animal experiments have shown the butyl alcohols to possess toxic properties, they have produced few cases of poisoning in industry because ot their low volatility. The use of normal butyl alcohol is reported to have resulted in irritation of the eyes, with corneal inflammation, slight headache and dizziness, slight irritation of the nose and throat, and dermatitis about the fingernails and along the sides of the fingers (Section 9). Keratitis has also been reported.
Fire Hazard: Dangerous, when exposed to heat or flame.
Underwriters Laboratory Classification: 40
Spontaneous Heating: No
To Fight Fire: Water spray, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame (Section 7).
Explosive Range: 1.7 - 18% (5)
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes, it can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11

sec-BUTYL ALCOHOL

Synonyms: 2-Butanol; ethylmethyl carbinol.
Description: Colorless liquid.
Formula: $CH_3CH_2CHOHCH_3$
Constants:
  Mol. Wt. 74.12
  M. P. −89°C
  B. P. 99.5°C
  Flash P. 75°F (C.C.)
  Density 0.808 @ 20°/4°C
  Autoign. Temp. 777°F
  Vap. Press. 10 mm @ 20°C
  Vap. D. 2.55
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 2
  Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
  Chronic Local: U
  Chronic Systemic: Ingestion 1; Inhalation 1; Skin Absorption 1

Fire Hazard: Dangerous, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water spray carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11

tert-**BUTYL ALCOHOL**

Synonym: 2-Methyl-2-propanol.
Description: Colorless liquid or rhombic prisms or planes.
Formula: $(CH_3)_3COH$
Constants:
- Mol. Wt. 74.12
- M. P. 25.3°C
- B. P. 82.8°C
- Flash P. 52°F (C.C.)
- Density 0.7887 @20°/4°C
- Autoign. Temp. 900°F
- Vap. Press. 40 mm @24.5°
- Vap. D. 2.55

Toxic Hazard Rating:
- Acute Local: Irritant 1
- Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Dangerous, when exposed to heat or flame; it can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, in the form of vapor when exposed to flame.
Explosive Range: 2.35 - 8.0%
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11

BUTYL ALDEHYDE See Butyraldehyde

BUTYLAMINE

Synonym: 1-Amino butane.
Description: Liquid, ammonia-like odor.
Formula: $C_4H_9NH_2$
Constants:
- Mol. Wt. 73.1
- M. P. −50°C
- B. P. 77°C
- Flash P. < 45°F (C.C.)
- Density 0.74-0.76 @20°/20°C
- Autoign. Temp. 594°F
- Vap. D. 2.52

Toxic Hazard Rating:
- Acute Local: Irritant 2; Ingestion 2; Inhalation 2
- Acute Systemic: U
- Chronic Local: U
- Chronic: Systemic: U

MAC: ACGIH (tentative); 5 parts per million of air.
Fire Hazard: Dangerous, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use optional): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

sec-**BUTYLAMINE**

Synonym: 2-Amino butane.
Description: Liquid.
Formula: $CH_3CH_2CH(NH_2)CH_3$
Constants:
- Mol. Wt. 73.1
- M. P. −104°C
- B. P. 63°C
- Flash P. 15°F
- Density 0.724 @20°C

Toxic Hazard Rating:
- Acute Local: Irritant 2; Ingestion 2; Inhalation 2
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Dangerous, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

tert-**BUTYLAMINE**
Synonyms: 2-Amino isobutane; trimethylaminomethane.
Description: Colorless liquid.
Formula: $(CH_3)_3CNH_2$
Constants:
Mol. Wt. 73.14
M. P. -67.5°C
B. P. 44 - 46°C
Density 0.700 @15°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

BUTYLAMINE OLEATE
Synonym: Monobutylamine oleate.
Description: Liquid.
Formula: $C_{17}H_{33}COONH_3C_4H_9$
Constants:
Mol. Wt. 355.6
Flash P. 150°F (O.C.)
Density 0.891
Toxicity: Details unknown. See Esters and Butylamine.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL AMINO BENZOATE
Synonym: n-Butyl p-amino-benzoate.
Description: Crystals.
Formula: $C_{11}H_{15}NO_2$
Constants:
Mol. Wt. 193.24
M. P. 57 - 29°C
B. P. 174°C @8 mm
Toxicity: Details unknown. See also Esters, Butyl Alcohol and p-Aminobenzoic Acid.
Caution: Can cause dermatitis (Section 9).
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

N,N-**BUTYL** p-**AMINOPHENOL**
Description: Crystals.
Formula: $HOC_6H_4HNCH_2CH_2CH_2CH_3$
Constants:
Mol. Wt. 165.2
M. P. -27°F
Flash P. 61°F
Toxicity: Unknown
Caution: May be an irritant or skin sensitizer.
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; it can react with oxidizing materials.
Storage and Handling: Section 7

BUTYL ANILINE
Description: Colorless liquid.
Formula: $(C_4H_9)NHC_6H_5$
Constants:
Mol. Wt. 149.23
B. P. 241°C
Flash P. 225°F (C.O.C.)
Freezing P. -15.1°C
Density 0.9288 @20°/20°C
Vap. Press. 0.02 mm @20°C
Vap. D. 5.15
Toxicity: Details unknown, probably highly toxic. See also Aniline.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of aniline; it can react vigorously with oxidizing materials.
Storage and Handling: Section 7

p-tert-**BUTYL ANILINE**
Synonym: 1-amino-4-tert-butyl benzene.
Description: Oil.
Formula: $(CH_3)_3CC_6H_4NH_2$
Constants:
Mol. Wt. 149.2
M. P. 17°C
B. P. 241°C
Density 0.9525 @15°/4°C

Toxicity: Details unknown. Probably toxic. See also Aniline.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of aniline.
Storage and Handling: Section 7

BUTYL BENZENE
Synonym: 1-Phenyl butane.
Description: Colorless liquid.
Formula: $C_6H_5CH_2CH_2CH_2CH_3$
Constants: Mol. Wt. 134.2
M. P. −81.2°C
B. P. 182.1°C
Freezing P. −88.2°C
Flash P. 160°F (T.O.C.)
Density 0.8601 @ 20°/4°C
Vap. Press. 1 mm @ 22.7°C
Toxicity: Details unknown. See Benzene.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

sec-BUTYL BENZENE
Synonym: 2-Phenyl butane.
Description: Colorless liquid.
Formula: $C_6H_5CH(CH_3)C_2H_5$
Constants: Mol. Wt. 134.2
M. P. −82.7°C
B. P. 173.5°C
Freezing P. −75.8°C
Flash P. 145°F (T.O.C.)
Density 0.8621 @ 20°C
Vap. Press. 1 mm @ 18.6°C
Vap. D. 4.62
Toxicity: Details unknown. See Benzene.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

tert-BUTYL BENZENE
Synonym: 2-methyl-2-phenyl propane.
Description: Colorless liquid.
Formula: $C_6H_5C(CH_2)_3$
Constants:
Mol. Wt. 134.2
B. P. 168.2°C
Freezing P. −58°C
Flash P. 140°F (T.O.C.)
Density 0.8665 @ 20°C
Vap. Press. 1 mm @ 13.0°C
Vap. D. 4.62
Toxicity: Details unknown. See Benzene.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL BENZOATE
Description: Liquid.
Formula: $C_6H_5COOC_4H_9$
Constants:
Mol. Wt. 178.22
M. P. −21.5°C
B. P. 250°C
Flash P. 225°F (O.C.)
Density 1.0073 @ 20°/20°C
Vap. Press. < 0.01 mm @ 20°C
Vap. D. 6.15
Toxicity: Details unknown. See also Esters, Benzoic Acid and N-butyl Alcohol.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

p-tert-BUTYL BENZOIC ACID
Synonym: p-t-BBA
Description: Colorless, fine crystalline powder.
Formula: $HOOCC_6H_4C(CH_3)_3$
Constants:
Mol. Wt. 178.11
M. P. 166.3°C
Density 1.142 @ 20°/4°C
Toxicity: Unknown
Fire Hazard: Slight; when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL BENZYL PHTHALATE
Description: Clear, oily liquid.
Formula: $C_4H_9COOC_6H_4COOCH_2C_6H_5$

Constants:
Mol. Wt. 312.4
M. P. < -35°C
B. P. 370°C
Flash P. 390°F
Density 1.116 @25°/25°C
Vap. D. 10.8

Toxicity: Details unknown. See also Esters.

Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.

To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

BUTYL BENZYL SEBACATE

Description: Liquid.

Formula: $(CH_2)_8CO_2C_4H_9CO_2C_6H_5CH_2$

Constants:
Mol. Wt. 348.5
B. P. 245 - 285°C @10 mm
Flash P. 395°F
Density 1.004 @20°/20°C
Vap. D. 12.0

Toxicity: See Esters.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

BUTYL BORIC ACID

Description: Colorless crystals.

Formula: $C_4H_9B(OH)_2$

Constants:
Mol. Wt. 101.95
M. P. 92 - 94°C
B. P. Decomposes

Toxicity: Details unknown. See Boron Compounds and Butyl Alcohol.

Fire Hazard: Slight; when heated, it emits toxic fumes. It may have flammable decomposition products (Section 6).

Storage and Handling: Section 7

tert-BUTYL BORIC ACID

Description: White crystals.

Formula: $C_4H_9B(OH)_2$

Constants:
Mol. Wt. 101.95
M. P. 105°C Decomposes
B. P. Decomposes

Toxicity: Unknown. See Boron Compounds and Butyl Alcohol.

Fire Hazard: Slight; when heated, it emits toxic fumes. It may have flammable products of decomposition (Section 6).

Storage and Handling: Section 7

BUTYL BROMIDE

Synonym: 1-Bromobutane.

Description: Colorless to pale straw-colored liquid.

Formula: $CH_3(CH_2)_2CH_2Br$

Constants:
Mol. Wt. 137.03
M. P. -112.4°C
B. P. 101.4°C
Flash P. 75°F (O.C.)
Density 1.274 @25°/25°C
Autoign. Temp. 600°F
Vap. D. 4.72

Toxicity: Details unknown. See also Halogenated Hydrocarbons.

Fire Hazard: Dangerous, when exposed to heat or flame.

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes of bromides; it can react with oxidizing materials.

Storage and Handling: Section 7

sec-BUTYL BROMIDE

Description: Colorless liquid.

Formula: $C_2H_5CHBrCH_3$

Constants:
Mol. Wt. 137.0
Freezing P. < -50°C
B. P. 91.4°C
Flash P. 70°F
Density 1.257 @25°/25°C

Toxicity: Unknown

Fire Hazard: Dangerous, when exposed to heat or flame.

To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Unknown

Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; it can react with oxidizing materials.

Storage and Handling: Section 7

tert-BUTYL BROMIDE

Description: Colorless liquid.

Formula: $(CH_3)_3CBr$
Constants: Mol. Wt. 137.0
M. P. -20°C
B. P. 73.3°C
Freezing P. -18°C
Density 1.215 @ 25°/25°C
Toxicity: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

BUTYL BUTYRATE
Synonym: Butyl butanoate.
Description: Liquid.
Formula:
$CH_3CH_2CH_2CO_2CH_2CH_2CH_2CH_3$
Constants:
Mol. Wt. 144.2
B. P. 166°C
Flash P. 128°F (O. C.)
Density 0.874
Vap. D. 5.0
Toxicity: Details unknown. See also Esters and Butyl Alcohol.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

BUTYL CARBINOL. See Amyl Alcohol.

sec-**BUTYL CARBINOL.** See sec-amyl Alcohol.

tert-**BUTYL CARBINOL.** See tert-amyl Alcohol.

BUTYL "CARBITOL"
Synonym: Diethylene glycol monobutyl ether.
Description: Colorless liquid.
Formula: $C_4H_9OCH_2CH_2OCH_2CH_2OH$
Constant:
Mol. Wt. 162.2
Freezing P. -68.1°C
B. P. 230.6°C
Flash P. 240°F (O. C.)
Density 0.9553 @ 20°/4°C
Autoign. Temp. 442°F
Vap. Press. 0.02 mm @ 20°C
Vap. D. 5.58
Toxicity: See Glycols.
Fire Hazard: Moderate, when exposed to heat or flame, it emits degradation products; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical, or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL "CARBITOL" ACETATE
Synonym: Diethylene glycol monobutyl ether acetate.
Description: Colorless liquid.
Formula:
$C_4H_9O(CH_2)_2O(CH_2)_2OOCCH_3$
Constants: Mol. Wt. 204.26
Freezing P. -32.2°C
B. P. 247°C
Flash P. 240°F (O. C.)
Density 0.981 @ 20°/20°C
Autoign. Temp. 570°F
Vap. Press. < 0.01 mm @ 20°C
Toxicity: See Glycols.
Fire Hazard: Moderate, when exposed to heat or flame it emits degradation products; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical, or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL "CARBITOL" THIOCYANATE
Formula: $C_4H_9O(CH_2)_2O(CH_2)_2CNS$
Constant:
Mol. Wt. 203.3
Toxicity: Details unknown. See also Thiocyanates.
Fire Hazard: Unknown
Disaster Control: See Thiocyanates.
Storage and Handling: Section 7

BUTYL CARBITYL 6-PROPYL PIPERONYL ETHER
Toxicity: Details unknown; an insecticide.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

p-tert-**BUTYL CATECHOL**
Description: White crystalline solid.
Formula: $CH_3CC_6H_3(OH)_2$

Constants:
  Mol. Wt. 166.2
  Freezing P. 52°C
  Flash P. 265°F
  B. P. 285°C
  Density 1.049 @60°/25°C
Toxic Hazard Rating:
  Acute Local: Irritant 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes and smoke; can react with oxidizing materials.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

BUTYL "CELLOSOLVE"

Synonyms: Glycol monobutyl ether; 2-butoxy ethanol.
Description: Colorless liquid.
Formula: $C_4H_9OCH_2CH_2OH$
Constants:
  Mol. Wt. 118.17
  M. P. < -40°F
  B. P. 171.2°C
  Flash P. 141°F (C.C.)
  Density 0.9027 @20°/4°C
  Autoign. Temp. 472°F
  Vap. Press. 0.6 mm @20°C
  Vap. D. 4.07
Toxicity: See Glycols
MAC: ACGIH (accepted): 200 parts per million in air; 965 milligrams per cubic meter of air.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL "CELLOSOLVE" ACETATE

Synonym: Glycol monobutyl ether acetate.
Description: Liquid.
Formula: $C_4H_9O(CH_2)_2OOCCH_3$
Constants:
  Mol. Wt. 160.20
  B. P. 370°F
  Flash P. 180°F (O.C.)
  Density 0.943
  Vap. D. 5.5
Toxicity: See Glycols.
Fire Hazard: Moderate; when exposed to heat or flame, it emits degradation products; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL CHLORIDE

Synonym: 1-Chlorobutane.
Description: Colorless liquid.
Formula: $CH_3(CH_2)_2CH_2Cl$
Constants:
  Mol. Wt. 92.57
  M. P. -123.1°C
  B. P. 78°C
  Flash P. 20°F (O.C.)
  Density 0.884
  Autoign. Temp. 880°F
  Vap. D. 3.20
Toxicity: Details unknown. See also Chlorinated Hydrocarbons.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame (Section 7).
Explosive Range: 1.85 - 10.1%
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene; it can react vigorously with oxidizing materials.
Storage and Handling: Section 7

BUTYL CITRATE

Synonyms: Butyl citrate; tributyl citrate.
Description: Colorless to pale yellow odorless liquid.
Formula: $(C_4H_9)_3C_6H_5O_7$
Constants:
  Mol. Wt. 360.4
  M. P. -20°C
  Flash P. 365°F
  B. P. 233°C @22 mm
  Density 1.045 @20°/20°C
  Vap. D. 12.4
Toxicity: Details unknown. See also Esters, Butyl Alcohol and Citric Acid.

Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL CROTONATE
Description: Water-white liquid, pleasant persistent odor.
Formula: $CH_3CHCHCOOC_4H_9$
Constants:
Mol. Wt. 142.2
B. P. 180.5°C
Density 0.9037 @20°/20°C
Vap. D. 4.9
Toxicity: Details unknown. See also Esters.
Fire Hazard: Dangerous, when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

BUTYL CYCLOHEXYLCAPROATE
Toxicity: Details unknown. See Esters and Butyl Alcohol.
Fire Hazard: A combustible material; it can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

BUTYL DECALIN
Description: Liquid.
Formula: $C_4H_9C_{10}H_{17}$
Constants: Mol. Wt. 194.35
Flash P. 500°F (C.C.)
Vap. D. 6.7
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

tert-BUTYL DECALIN
Description: Liquid
Formula: $C_4H_9C_{10}H_{17}$
Constants: Mol. Wt. 194.4
Flash P. 640°F (C.C.)
Vap. D. 6.7
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL DIAMYLAMINE
Description: Liquid.
Formula: $(C_4H_9)(C_5H_{11})_2N$
Constants:
Mol. Wt. 213.4
B. P. 444°F
Flash P. 200°F
Density 0.78
Vap. D. 7.3
Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL DICHLOROARSINE
Description: Oily liquid, somewhat agreeable odor.
Formula: $C_4H_9AsCl_2$
Constants:
Mol. Wt. 202.945
B. P. 194°C
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

BUTYL 2,4-DICHLOROPHENOXYACETATE
Synonyms: 2,4-D; Butyl ester.
Description: Light-brown liquid.
Formula: $C_6H_3(Cl)_2OCH_2COO(CH_2)_3$-$CH_3$
Constants:
Mol. Wt. 277.15
Density 1.235 - 1.245 @25°/25°C
Toxicity: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes.
Storage and Handling: Section 7

BUTYL DIETHANOLAMINE
Description: Liquid.
Formula: $C_4H_9N(CH_2CH_2OH)_2$
Constants:
Mol. Wt. 161.24
B. P. 503°F
Flash P. 245°F (O.C.)
Density 0.97
Vap. D. 5.55

Toxicity: Details unknown. See Amines.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL DIETHYL HEPTYLATE

Description: Liquid.
Formula:
$C_4H_8(COOCH_2CH(C_2H_5)C_4H_8)_2$
Constants:
Mol. Wt. 370.56
M. P. −60°C
B. P. 214°C @ 5 mm
Flash P. 385°F (O. C.)
Density 0.9268 @ 20°/20°C
Vap. D. 12.8
Toxicity: Details unknown. See also Esters.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2-sec-BUTYL-6-4-DINITROPHENOL

Description: Crystals.
Formula: $(C_4H_9)(NO_2)(C_6H_3OH)$
Constant:
Mol. Wt. 195.2
Toxicity: Details unknown. See also Butyl Alcohol and Dinitrophenol.
Fire Hazard: Details unknown. See Nitrates,
Disaster Control: See Nitrates.
Storage and Handling: Section 7

alpha-BUTYLENE

Synonym: 1-Butene
Description: Gas
Formula: $CH_3CH_2CHCH_2$
Constants: Mol. Wt. 56.10
B. P. −6.3°C
Freezing P. −185.3°C
Flash P. −112°F
Density 0.668 @ 0°/1°C
Vap. D. 1.93
Vap. Press. 3480 mm @ 21°C
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Inhalation 2
Chronic Local: U
Chronic Systemic: U
Caution: An anesthetic and asphyxiant.
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or water spray (Section 6).
Explosion Hazard: Moderate, when exposed to flame (Section 7).
Explosive Range 1.7 - 9.0%
Disaster Control: Moderately dangerous; shock can shatter the compressed gas container with explosive force; it can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

beta-**BUTYLENE**. See 2-Butene.

gamma-**BUTYLENE**. See Isobutylene.

BUTYLENE CHLORIDE

Description: Gas.
Formula: C_4H_7Cl
Constants:
Mol. Wt. 90.6
B. P. 162°F
Density 0.926
Vap. D. 3.13
Toxicity: Details unknown. See also Chlorinated Hydrocarbons.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame (Section 7).
Explosive Range: 2.25 - 9.25%
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene; it can react vigorously with oxidizing materials.
Storage and Handling: Section 7

1,2-BUTYLENE GLYCOL

Synonym: alpha-Butylene glycol.
Description: Liquid.
Formula: $CH_3CH_2CH(OH)CH_2OH$
Constants:
Mol. Wt. 90.1
M. P. −174°F
B. P. 192°C
Density 1.019 @ 0°/4°C
Vap. D. 3.1

Toxicity: Details unknown. See also Glycols.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials (Section 6).
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

1,3-BUTYLENE GLYCOL

Synonyms: 1,3-Butanediol; beta-butylene glycol.
Description: Viscous liquid.
Formula: $CH_3CH(OH)CH_2CH_2OH$
Constants:
- Mol. Wt. 90.12
- B. P. 207.5°C
- Freezing P. below −50°C
- Flash P. 228°F (C.C.)
- Density 1.006 @20°/20°C
- Autoign. Temp. 710°F
- Vap. Press. 0.06 mm @20°C
- Vap. D. 3.2

Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2,3-BUTYLENE GLYCOL

Synonyms: 2,3 Butanediol; pseudobutylene glycol.
Description: Colorless liquid.
Formula: $CH_3CH(OH)CH(OH)CH_3$
Constants:
- Mol. Wt. 90.12
- B. P. 180°C
- Freezing P. 19°C
- Flash P. 185°F (T.O.C.)
- Density 1.0095 @20°/20°C
- Autoign. Temp. 710°F
- Vap. Press. 0.17 mm @20°C
- Vap. D. 3.1

Toxicity: Details unknown. See also Glycols.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials (Section 6).
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYLENE OXIDES

Description: A liquid mixture of isomeric butylene oxides.
Formula: C_4H_8O
Constants:
- Mol. Wt. 72.1
- B. P. 62 - 65°C
- Flash P. 5°F
- Pour P. −150°C
- Density 0.826 @25°/25°C
- Vap. D. 2.49

Toxic Hazard Rating:
- Acute Local: Irritant 3; Inhalation 3
- Acute Systemic: Ingestion 3; Inhalation 3
- Chronic Local: U
- Chronic Systemic: U

Caution: Highly toxic concentrations of vapor are readily obtained at room temperature.
Fire Hazard: Dangerous, when exposed to heat or flame; reacts with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, in the form of vapor when exposed to flame (Section 7).
Explosive Range: 1.5 - 18.3%
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

BUTYLETHANOLAMINE

Synonym: 2-Butylaminoethanol.
Description: Liquid.
Formula: $CH_3(CH_2)_3NHCH_2CH_2OH$
Constants:
- Mol. Wt. 117.19
- B. P. 377°F
- Flash P. 170°F (O.C.)
- Density 0.89
- Vap. D. 4.03

Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL ETHER
Synonyms: 1-Butoxybutane; n-dibutyl ether.
Description: Colorless liquid.
Formula: $CH_3(CH_2)_3O(CH_2)_3CH_3$
Constants: Mol. Wt. 130.23
M. P. −95°C
B. P. 142°C
Flash P. 171°F (C.C.)
Density 0.769 @20°/20°C
Autoign. Temp. 382°F
Vap. D. 4.48
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate. See Ethers.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate. See also Ethers (Section 7).
Disaster Control: Moderately dangerous; when heated, it emits acrid fumes; it can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
MCA warning label.

BUTYL ETHYL "CELLOSOLVE"
Description: Liquid.
Formula: $C_4H_9OCH_2CH_2OC_2H_5$
Constants:
Mol. Wt. 146.22
M. P. −90°C
B. P. 164.2°C
Density 0.8389
Toxicity: See Glycols and "Cellosolves."
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials.
Storage and Handling: Section 7

BUTYL FORMAL. See Formaldehyde and Butyl Alcohol.

BUTYL FORMATE
Synonym: Butyl methanoate.
Description: Colorless liquid.
Formula: $HCOOCH_2CH_2CH_2CH_3$
Constants:
Mol. Wt. 101.12
M. P. −130°F
B. P. 106.0°C
Flash P. 64°F (C.C.)
Density 0.911
Autoign. Temp. 612°F
Vap. Press. 40 mm @31.6°C
Vap. D. 3.52
Toxicity: Details unknown. See also Esters, Butyl Alcohol and Formic Acid.
Fire Hazard: Dangerous, when exposed to heat or flame; it can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

tert-BUTYL HYDROPEROXIDE
Description: Liquid.
Formula: $(CH_3)_3COOH$
Constants:
Mol. Wt. 90.12
Flash P. 55°F (C.C.)
Density 0.860
Vap. D. 2.07
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame, or by spontaneous chemical reaction; can react with reducing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

p,p-sec-BUTYLIDENEDIPHENOL
Description: Tan, granular solid.
Formula: $(HOC_6H_4)_2C(CH_3)(C_2H_5)$
Constants:
Mol. Wt. 242.3
M. P. 118.9 - 121.7°C
Toxicity: Details unknown. See also Phenols.
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials.
Storage and Handling: Section 7

tert-BUTYL ISOPROPYL BENZENE HYDROPEROXIDE
Description: Crystals.
Formula: $(C_4H_9)(C_3H_7)C_6H_3OOH$

Constant:
Mol. Wt. 208.3
Toxicity: Unknown
Fire Hazard: Moderate when exposed to heat or flame or by chemical reaction; it can react with oxidizing or reducing materials (Section 6).
Storage and Handling: Section 7

BUTYL LACTATE
Description: Liquid.
Formula: $CH_3CH(OH)COOC_4H_9$
Constants:
Mol. Wt. 146.18
M. P. -43°C
B. P. 188°C
Flash P. 168°F (T. O. C.)
Density 0.968
Autoign. Temp. 720°F
Vap. D. 5.04
Vap. Press. 0.4 mm @20°C
Toxicity: See Esters, Butyl Alcohol and Lactic Acid.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL MERCAPTAN
Synonyms: 1-Butanethiol; n-butyl thioalcohol.
Description: Colorless liquid; skunk-like odor.
Formula: $CH_3(CH_2)_2CH_2SH$
Constants:
Mol. Wt. 90.18
M. P. -116°C
B. P. 98°C
Density 0.8365 @25°/4°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: Inhalation 2
MAC: ACGIH (tentative); 10 parts per million in air.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes; it emits highly toxic fumes; it can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Inflammable liquid; red label.

sec-BUTYL MERCAPTAN
Synonym: 2-Butanethiol.
Description: Mobile liquid, skunk-like odor.
Formula: $C_4H_{10}S$
Constants:
Mol. Wt. 90.2
M. P. -165°C
B. P. 85°C
Density 0.83 @17°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingsstion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: Inhalation 2
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes; it can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

tert-BUTYL MERCAPTAN
Synonym: 2-Methyl-2-propanethiol.
Description: Liquid; skunk-like odor.
Formula: $C_4H_{10}S$
Constants:
Mol. Wt. 90.2
M. P. -0.5°C
B. P. 64°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: Inhalation 2
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when

heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes; it can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

BUTYL MESITYL OXIDE
Synonyms: Indalone; butopyronoxyl.
Description: Yellow to pale reddish liquid.
Formula: $C_{12}H_{18}O_4$
Constants:
Mol. Wt. 226.3
B. P. 256 - 270°C
Density 1.052 - 1.060 @25°/25°C
Toxicity: Unknown; an insecticide.
Fire Hazard: Slight; when heated, it emits smoke (Section 6).
Storage and Handling: Section 7

BUTYL METHACRYLATE, MONOMER
Description: Colorless liquid.
Formula: $CH_2C(CH_2)COOC_4H_9$
Constants:
Mol. Wt. 142.19
B. P. 163°C
Flash P. 130°F (O.C.)
Density 0.895 @20°/4°C
Vap. D. 4.8
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 3; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

BUTYL METHYL KETONE. See Methyl Butyl Ketone.

BUTYL MONOETHANOLAMINE
Description: Liquid.
Formula: $C_4H_9NHC_2H_4OH$
Constants:
Mol. Wt. 117.19
B. P. 378°F
Flash P. 170°F (O.C.)
Density 0.89
Vap. D. 4.03
Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL NAPHTHALENE
Description: Liquid.
Formula: $C_4H_9C_{10}H_7$
Constants:
Mol. Wt. 184.3
Flash P. 680°F (C.C.)
Vap. D. 6.2
Toxicity: Details unknown. See also Naphthalene.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL NICOTINATE
Description: Colorless liquid.
Formula: $C_{10}H_{13}NO_2$
Constants:
Mol. Wt. 179.3
B. P. 122 - 123°C @8 mm
Density 1.0471 @25°/4°C
Toxicity: Details unknown. See also Esters.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; it can react vigorously on contact with oxidizing materials.
Storage and Handling: Section 7

BUTYL NITRATE
Description: Liquid.
Formula: $CH_3(CH_2)_3ONO_2$
Constants:
Mol. Wt. 119.1
B. P. 136°C
Flash P. 97°F
Density 1.048 @0°/4°C
Vap. D. 4.0

Toxicity: Details unknown. See also Nitrates and Butyl Alcohol.
Fire Hazard: Moderate, when exposed to heat or flame or by spontaneous chemical reaction (Section 6).
Caution: An oxidizer.
Explosion Hazard: See Nitrates.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; it can react vigorously with oxidizing or reducing materials.
Storage and Handling: Section 7

sec-BUTYL NITRATE
Synonym: alpha-methyl propyl nitrate.
Description: Liquid.
Formula: $C_2H_5CH(CH_3)ONO_2$
Constants:
Mol. Wt. 119.1
B. P. 124°C
Density 1.0382 @0°/4°C
Vap. D. 4.0
Toxicity: Details unknown. See Nitrates and sec-Butyl Alcohol.
Fire Hazard: Moderate, when exposed to heat or flame or by spontaneous chemical reaction (Section 6).
Caution: An oxidizer.
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

BUTYL NITRITE
Description: Liquid.
Formula: $CH_3(CH_2)_3ONO$
Constants:
Mol. Wt. 103.1
B. P. 75°C
Density 0.9114 @0°/4°C
Vap. D. 3.5
Toxicity: Details unknown. See also Nitrites and sec-Butyl Alcohol.
Fire Hazard: Moderate, when exposed to heat or flame or by spontaneous chemical reaction (Section 6).
Caution: An oxidizer.
Explosion Hazard: See Nitrites.
Disaster Control: See Nitrites.
Storage and Handling: Section 7

sec-BUTYL NITRITE
Synonym: alpha-methyl propyl nitrite.
Description: Liquid.
Formula: $C_2H_5CH(CH_3)ONO$
Constants:
Mol. Wt. 103.1
B. P. 68°C
Density 0.8981 @0°/4°C
Vap. D. 3.5
Toxicity: Details unknown. See Nitrites and Butyl Alcohol.
Fire Hazard: Moderate, when exposed to heat or flame or by spontaneous chemical reaction (Section 6).
Caution: An oxidizer.
Explosion Hazard: See Nitrites.
Disaster Control: See Nitrites.
Storage and Handling: Section 7

tert-BUTYL NITRITE
Synonyms: alpha, alpha-dimethyl ethyl nitrite.
Description: Yellowish liquid.
Formula: $(CH_3)_3CONO$
Constants:
Mol. Wt. 103.1
B. P. 63°C
Density 0.8941 @0°/4°C
Vap. D. 3.5
Toxicity: Details unknown. See also Nitrites and tert-Butyl Alcohol.
Fire Hazard: Moderate, when exposed to heat or flame or by spontaneous chemical reaction (Section 6).
Caution: An oxidizer.
Explosion Hazard: See Nitrites.
Disaster Control: See Nitrites.
Storage and Handling: Section 7

2-BUTYL OCTANOL
Description: Liquid.
Formula: $C_6H_{13}CH(C_4H_9)CH_2OH$
Constants:
Mol. Wt. 186.33
M. P. -80°C
Flash P. 230°F (O. C.)
B. P. 253.3°C
Density 0.8355 @20°/20°C
Vap. D. 6.42
Toxicity: Details unknown. See also Alcohols.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL OLEATE
Description: Liquid.
Formula: $C_{17}H_{33}COOC_4H_9$
Constants:
Mol. Wt. 338.56
B. P. 343°F
Flash P. 356°F (O.C.)
Density 0.873
Vap. D. 11.3
Toxicity: Details unknown. See also esters, butyl Alcohol and Oleic Acid.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, or dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL OXALATE
Synonym: Butyl ethane dioate.
Description: Liquid.
Formula: $(COOC_4H_9)_2$
Constants:
Mol. Wt. 202.24
Flash P. 265°F (O.C.)
Density 0.989 - 0.993
Vap. D. 7.0
Toxicity: Details unknown. See also Esters, Butyl Alcohol and Oxalic Acid.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

tert-**BUTYL PERBENZOATE**
Description: Liquid.
Formula: $C_6H_5COOOC(CH_3)_3$
Constants:
Mol. Wt. 194.2
B. P. 235°F Decomposes
Flash P. 66°F (C.C.)
Density 1.035
Vap. D. 6.69
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame or by spontaneous chemical reaction; it can react with reducing materials.
Spontaneous Heating: No
Caution: A powerful oxidizer.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Slight, when exposed to heat or by spontaneous chemical reaction (Section 7).
Storage and Handling: Section 7

o-sec-**BUTYL PHENOL**
Description: Colorless liquid.
Formula: $(CH_3CHC_2H_5)C_6H_4OH$
Constants: Mol. Wt. 150.2
B. P. 226 - 228°C @25 mm
Freezing P. 12°C
Flash P. 225°F
Density 0.981 @25°/25°C
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

p-sec-**BUTYL PHENOL**
Description: Nearly white flakes.
Formula: $(CH_3CHC_2H_5)C_6H_4OH$
Constants:
Mol. Wt. 150.2
B. P. 135.4 - 136.5°C @25 mm
Freezing P. 51°C
Flash P. 240°F
Density 0.963 @60°/60°C
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderate; when heated to decomposition, it emits toxic fumes; it can react with oxidizing materials.
Storage and Handling: Section 7

p-tert-**BUTYL PHENOL**
Synonyms: Butyl phenol.
Description: Crystals or practically white flakes.
Formula: $C_4H_9C_6H_4OH$
Constants:
Mol. Wt. 150.2
B. P. 238°C
Freezing P. 97°C
Density 0.9081 @114°/4°C
Vap. Press. 1 mm @70.0°C
Vap. D. 5.1
Toxicity: See Phenol.
Disaster Control: Moderately dangerous; when heated to

decomposition, it emits toxic fumes.
Storage and Handling: Section 7

2-(p-sec-**BUTYLPHENOXY) ETHANOL.** See Ethylene Glycol p-sec-buty phenyl Ether.

2-(p-tert-**BUTYLPHENOXY) ETHYL ACETATE** See Ethylene Glycol p-tert-butyl phenyl Ether Acetate.

1-(o-sec-**BUTYLPHENOXY)-2-PROPANOL.** See Propylene Glycol o-sec-butyl phenyl Ether.

1-(p-sec-**BUTYLPHENOXY)-2-PROPANOL.** See Propylene Glycol p-sec-butyl phenyl Ether.

1-(p-tert-**BUTYLPHENOXY)-2-PROPANOL.** See Propylene Glycol p-tert-butyl phenyl Ether.

p-tert-**BUTYLPHENYL DIPHENYL PHOSPHATE.** See Diphenyl mono-(p-tert-butyl phenyl) phosphate.

BUTYL PHENYL ETHER

Description: Liquid
Formula: $C_4H_9OC_6H_5$
Constants: Mol. Wt. 150.1
Flash P. 180°F
Density 0.929 @20°C
Vap. D. 5.6
Toxicity: Details unknown. See also Ethers.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials. See also Ethers.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Slight, by spontaneous chemical reaction. See also Ethers.
Storage and Handling: Section 7

BUTYL PHTHALYL BUTYL GLYCOLATE

Description: Liquid.
Formula: $C_6H_4(CO_2)_2(C_4H_9)CH_2CO_2C_4H_9$
Constants:
Mol. Wt. 331.3
B. P. 653°F
Flash P. 390°F (O.C.)
Density 1.097
Vap. D. 11.6
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL PIPERONYLAMIDE

Description: Crystals.
Formula: $CH_2(O_2)C_6H_2(C_4H_9)CONH_2$
Constants:
Mol. Wt. 221.3
Vap. D. 7.4
Toxicity: Unknown; an insecticide.
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes.
Storage and Handling: Section 7

BUTYL PROPIONATE

Synonym: Butyl proponoate.
Description: Water-white liquid, apple-like odor.
Formula: $C_2H_5CO_2C_4H_9$
Constants:
Mol. Wt. 130.2
M. P. −89.6°C
B. P. 145.4°C
Flash P. 63°F (C.C.)
Density 0.875 @20°C
Autoign. Temp. 800°F
Vap. D. 4.49
Toxicity: Details unknown. See also Esters, N-butyl Alcohol and Propionic Acid.
Fire Hazard: Dangerous, when exposed to heat or flame; it can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL RICINOLEATE

Synonym: Butyl-12-hydroxy-9-octadecanoate.
Description: Liquid.
Formula: $C_{18}H_{33}O_3C_4H_9$
Constants:
Mol. Wt. 354.56
B. P. 275°C @13 mm
Flash P. 428°F

Density 0.906
Vap. D. 12.2
Toxicity: Details unknown. See also Esters and Butyl Alcohol.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL STEARAMIDE

Description: Liquid.
Formula: $C_4H_9C_{17}H_{34}CONH_2$
Constants: Mol. Wt. 339.6
B. P. 383°F
Flash P. 430°F
Vap. D. 11.7
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL STEARATE

Description: Liquid.
Formula: $C_{17}H_{35}COOC_4H_9$
Constants:
Mol. Wt. 340.57
M. P. 61°F
B. P. 650°F
Flash P. 320°F (C.C.)
Density 0.855
Vap. D. 11.4
Toxicity: Details unknown. See also Esters and N-butyl Alcohol.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL SULFIDE

Synonyms: Dibutyl sulfide; butyl thiobutane.
Description: Liquid.
Formula: $(CH_3CH_2CH_2CH_2)_2S$
Constants:
Mol. Wt. 146.3
M. P. −80°C
B. P. 182°C
Density 0.839 @16°/0°C
Vap. D. 4.9
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame or on contact with acid or acid fumes.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; it can react vigorously with oxidizing materials.
Storage and Handling: Section 7

BUTYL TARTRATE. See Dibutyl Tartrate.

tert-BUTYL TETRALIN

Description: Liquid.
Formula: $C_4H_9C_{10}H_{11}$
Constants:
Mol. Wt. 188.30
Flash P. 680°F (C.C.)
Vap. D. 6.3
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYL TITANATE

Synonym: Titanium butylate.
Description: Colorless to light-yellow liquid, odor of butanol.
Formula: $Ti(OC_4H_9)_4$
Constants:
Mol. Wt. 340.4
M. P. −55°C
B. P. 312°C
Flash P. 170°F
Vap. D. 11.5
Toxicity: See Butyl Alcohol and Titanium Compounds.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

sec-BUTYL TITANATE

Description: A clear liquid.
Formula: $Ti[OCH(CH_3)(C_2H_5)]_4$
Constants:
Mol. Wt. 340
M. P. −25 to −30°C
B. P. 138°C @10 mm
Density 0.93
Toxicity: See Esters and sec-Butanol
Fire Hazard: Moderate, when

exposed to heat or flame; it can react with oxidizing materials.
Storage and Handling: Section 7

p-tert-BUTYL TOLUENE

Description: Colorless liquid.
Formula: $C_4H_9C_6H_4CH_3$
Constant:
Mol. Wt. 148.24
Toxic Hazard Rating:
Acute Local: Irritant 3
Acute Systemic: Ingestion 3; Inhalation 2; Skin Absorption 2
Chronic Local: Irritant 2
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 2
MAC: ACGIH (proposed); 10 parts per million in air.
Fire Hazard: Moderate, when exposed to heat or flame.
Disaster Control: Dangerous; when heated, it emits highly toxic fumes; it can react with oxidizing materials.
Storage and Handling: Section 7

BUTYL TRICHLOROSILANE

Description: Liquid.
Formula: $C_4H_9SiCl_3$
Constants:
Mol. Wt. 191.6
Vap. D. 6.4
Toxicity: Details unknown. See also Chlorosilanes.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; it will react with water or steam to produce heat, toxic and corrosive fumes.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

BUTYL VINYL ETHER

Description: Liquid.
Formula: $CHCH_2OC_4H_9$
Constants:
Mol. Wt. 100.2
M. P. −92°C
B. P. 200°F
Flash P. 30°F
Density 0.77
Vap. D. 3.4
Toxicity: Details unknown. See also Ethers.
Explosion Hazard: Moderate, by spontaneous chemical reaction (Section 7). See also Ethers.
Fire Hazard: Dangerous. See Ethers.

BUTYN

Synonym: p-Aminobenzoyl-gamma-di-n-butyl aminopropanol sulfate.
Description: Colorless, odorless powder.
Formula: $(NH_2C_6H_4COO(CH_2)_3N(C_6H_9)_2)_2H_2SO_4$
Constants:
Mol. Wt. 836.8
M. P. 98 - 100°C
Toxicity: A weak allergen.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

2-BUTYNE-1,4-DIOL

Description: Straw to amber crystals.
Formula: $C_4H_6O_2$
Constants:
Mol. Wt. 86.1
M. P. 57.5°C
B. P. 194°C @100 mm
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Explosion Hazard: Moderate, when exposed to heat or by spontaneous chemical reaction in contact with certain materials.
Explosive Range: Upon contamination with mercury salts, strong acids and alkali earth hydroxides and halides at high temperatures.
Disaster Control: Dangerous; when heated to decomposition it emits acrid fumes and may explode.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

BUTYRALDEHYDE

Synonyms: Butanal; butyric aldehyde; n-butyl aldehyde.
Description: Colorless liquid.
Formula: $CH_3(CH_2)_2CHO$

Constants:
Mol. Wt. 72.1
M. P. -100°C
B. P. 75.7°C
Flash P. 20°F (C.C.)
Density 0.817 @20°/4°C
Autoign. Temp. 446°F
Vap. D. 2.5
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame; it can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

BUTYRALDEHYDE ANILINE

Description: Liquid.
Formula: $CH_3(CH_2)_2CONHC_6H_5$
Constants:
Mol. Wt. 163.2
Vap. D. 5.5
Toxicity: Details unknown; may contain aniline. See also Aniline.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of aniline; it can react vigorously with oxidizing materials.
Storage and Handling: Section 7

BUTYRALDOXIME

Synonym: Butanal oxime.
Description: Liquid.
Formula: C_4H_8NOH
Constants: Mol. Wt. 87.1
M. P. -29.5°C
B. P. 306°F
Flash P. 136°F (C.C.)
Density 0.923
Vap. D. 3.01
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYRIC ACID

Description: Liquid.
Formula: $CH_3(CH_2)_2COOH$
Constants:
Mol. Wt. 88.10
M. P. -7.9°C
B. P. 163.5°C
Flash P. 170°F (C.O.C.)
Freezing P. -5.5°C
Density 0.9590 @20°/20°C
Autoign. Temp. 1026°F
Vap. Press. 0.43 mm @20°C
Vap. D. 3.04
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: Ingestion 1; Inhalation 1
Chronic Local: Irritant 1
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

BUTYRIC ANHYDRIDE

Synonym: Butanoic anhydride.
Description: Liquid.
Formula: $(CH_3(CH_2)_2CO)_2O$
Constants:
Mol. Wt. 158.19
M. P. -73.3°C
B. P. 198°C
Flash P. 190°F (C.C.)
Density 0.978
Vap. D. 5.4
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: Ingestion 1; Inhalation 1
Chronic Local: Irritant 1
Chronic Systemic: U

Fire Hazard: Moderate; when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

gamma-BUTYROLACTONE

Description: Colorless liquid; mild odor.
Formula: $C_4H_6O_2$
Constants:
Mol. Wt. 86
M. P. -44°C
B. P. 206°C
Flash P. 209°F (O. C.)
Density 1.124 @25°/4°C
Vap. D. 3.0
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Ingestion 1
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

BUTYRONE

Synonym: 4-Heptanone.
Description: Liquid.
Formula: $(C_3H_7)_2CO$
Constants: Mol. Wt. 114.18
B. P. 290°F
M. P. -326°C
Flash P. 120°F (C. C.)
Density 0.815
Vap. D. 3.93
Toxicity: Details unknown. See also Ketones.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizng materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

BUTYRYL CHLORIDE

Synonym: Butanoyl chloride.
Description: Clear, colorless liquid with sharp odor.
Formula: C_3H_7COCl
Constants:
Mol. Wt. 106.6
M. P. -89°C
B. P. 100 - 110°C
Density 1.028 @20°/4°C
Vap. D. 3.67
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: Irritant 1
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; it will react with water or steam to produce toxic and corrosive fumes; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

C

CACODYL
Synonyms: Dicacodyl; tetramethyl diarsine.
Description: Oily liquid.
Formula: $(CH_3)_2As-As(CH_3)_2$
Constants:
  Mol. Wt. 210.0
  B. P. 165°C
  Freezing P. -6°C
  Density Above 1
Toxicity: See Arsenic Compounds.
Fire Hazard: Dangerous; by spontaneous chemical reaction. Ignites spontaneously in dry air (Section 6).
Spontaneous Heating: Yes
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of arsenic; it can react vigorously with oxidizing materials.
First Aid: Section 1
Personal Hygiene: Section 3
Storage and Handling: Section 7

CACODYL DIOXIDE
Description: A liquid.
Toxicity: See Arsenic Compounds.
Fire Hazard: Dangerous, by spontaneous chemical reaction. Ignites spontaneously in air (Section 6).
Spontaneous Heating: Yes
Explosion Hazard: Unknown
Disaster Control: Dangerous; shock can shatter the container and release contents; when heated to decomposition it emits highly toxic fumes of arsenic; can react vigorously with oxidizing materials.
First Aid: Section 1
Personal Hygiene: Section 3
Storage and Handling: Section 7

CACODYLIC ACID
Synonyms: Dimethylarsenic acid; alkargen.
Description: Colorless crystals.
Formula: $(CH_3)_2AsOOH$
Constants:
  Mol. Wt. 138.0
  M. P. 200°C
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.

CACODYL SULFIDE
Description: Liquid.
Toxicity: See Arsenic Compounds and Sulfides.
Fire Hazard: Dangerous, when exposed to heat or by spontaneous chemical reaction. Ignites spontaneously in air (Section 6).
Spontaneous Heating: Yes
Explosion Hazard: Unknown
Disaster Control: Dangerous; shock can shatter the container and release contents; when heated to decomposition, it emits highly toxic fumes of arsenic and oxides of sulfur; it can react vigorously with oxidizing materials.
First Aid: Section 1
Personal Hygiene: Section 3
Storage and Handling: Section 7

CADE OIL
Synonym: Juniper tar.
Description: Dark brown, viscous, volatile oil.
Constant:
  Density 0.950 - 1.055 @25°/25°C
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: A combustible

material; when heated, it emits acrid fumes, can react with oxidizing materials (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

CADMIUM

Description: Hexagonal crystals; silver-white malleable metal.
Formula: Cd
Constants:
At. Wt. 112.41
M. P. 320.9°C
B. P. 767 ± 2°C
Density 8.642
Vap. Press. 1 mm @394°C
MAC: ACGIH (accepted); 0.1 milligram per cubic meter of air
See also Cadmium Compounds.
Radiation Hazard (Section 5): Artificial isotope Cd^{109}, half-life: 470 days; emits gamma rays of 0.088 mev and a positron. The permissible levels are: In body: 40 microcuries. In air: 7×10^{-8} microcurie per milliliter. In water: 7×10^{-2} microcurie per milliliter. Cd^{109} exists in equilibrium with its daughter, the radioactive form of Ag^{109}. The permissible levels are given for the equilibrium mixture.
Toxicity: Cadmium plating of food and beverage containers has resulted in a number of outbreaks of gastro-enteritis (food poisoning).
Fire Hazard: Moderate, in the form of dust when exposed to heat or flame or by chemical reaction with oxidizing agents (Section 6).
See also Powdered Metals.
Explosion Hazard: Slight, in the form of dust when exposed to flame (Section 7).
Disaster Control: Dangerous; when heated, it emits highly toxic fumes of cadmium; it can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

CADMIUM ACETATE

Description: Monoclinic colorless crystals, odor of acetic acid.
Formula: $Cd(C_2H_3O_2)_2$
Constants:
Mol. Wt. 230.50
M. P. 256°C
B. P. Decomposes
Density 2.341
Toxicity: See Cadmium Compounds

CADMIUM AMIDE

Description: White solid.
Formula: $Cd(NH_2)_2$
Constants:
Mol. Wt. 144.46
M. P. Decomposes @120°C
Density 3.05 @25°C
Toxicity: See Cadmium Compounds.

CADMIUM AMMONIUM BROMIDE

Synonyms: Ammonium-cadmium bromide.
Description: Colorless crystals.
Formula: $CdBr_2 \cdot 4NH_4Br$
Constant:
Mol. Wt. 664.00
Toxicity: See Cadmium Compounds and Bromides.

CADMIUM ARSENIDE

Description: Dark-gray cubes.
Formula: Cd_3As_2
Constants:
Mol. Wt. 487.05
M. P. 721°C
Density 6.21 @15°/4°C
Toxicity: See Arsenic Compounds and Cadmium Compounds.
Fire Hazard: Moderate, when exposed to heat or flame. May evolve arsine upon contact with moisture or acids (Section 6).
Explosion Hazard: Moderate when exposed to flame (Section 7).
See also Arsine.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes it emits highly toxic fumes of arsenic; will react violently with water or steam or oxidizing materials.
First Aid: Section 1
Personal Hygiene: Section 3
Storage and Handling: Section 7

CADMIUM BENZOATE

Description: White solid.
Formula: $Cd(C_7H_5O_2)_2 \cdot 2H_2O$
Constant:
Mol. Wt. 390.66
Toxicity: See Cadmium Compounds.
Disaster Control: See Cadmium.
Storage and Handling: Section 7

CADMIUM BOROTUNGSTATE
Description: Yellow, triclinic crystals.
Formula: $Cd_5(BW_{12}O_{40})_2 \cdot 18H_2O$
Constants:
Mol. Wt. 6602.06
M. P. 75°C
Toxicity: See Cadmium Compounds and Boron Compounds.

CADMIUM BROMATE
Description: Rhombic, white crystals.
Formula: $Cd(BrO_3)_2 \cdot H_2O$
Constants:
Mol. Wt. 386.26
M. P. Decomposes
Density 3.758
Toxicity: See Cadmium Compounds and Bromates.
Fire Hazard: Moderate, by chemical reaction with reducing agents (Section 6).
Caution: A powerful oxidizing agent.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of cadmium, bromine and bromides; it can react vigorously with reducing materials.
Storage and Handling: Section 7

CADMIUM BROMIDE
Description: Yellow crystals.
Formula: $CdBr_2$
Constants:
Mol. Wt. 272.24
M. P. 567°C
B. P. 963°C
Density 5.192 @25°C
Toxicity: See Cadmium Compounds and Bromides.

CADMIUM CARBONATE
Description: Trigonal, white crystals.
Formula: $CdCO_3$
Constants:
Mol. Wt. 172.42
M. P. Decomposes < 500°C
Density 4.258 @4°C
Toxicity: See Cadmium Compounds.

CADMIUM CHLORATE
Description: Colorless, deliquescent prisms.
Formula: $Cd(ClO_3)_2 \cdot 2H_2O$
Constants:
Mol. Wt. 315.36
M. P. 80°C
Density 2.28 @18°C
Toxicity: See Cadmium Compounds and Chlorates.
Fire Hazard: Moderate, by chemical reaction with reducing agents (Section 6).
Caution: A powerful oxidizing agent. See also Chlorates.
Explosion Hazard: Moderate, when shocked or exposed to heat. See also Chlorates.
Disaster Control: Dangerous; heat and shock will explode it; when heated to decomposition, it emits highly toxic fumes of cadmium chlorine and chlorides; it can react vigorously with reducing materials.
First Aid: Section 1
Personal Hygiene: Section 3
Storage and Handling: Section 7

CADMIUM CHLORIDE
Description: Hexagonal, colorless crystals.
Formula: $CdCl_2$
Constants:
Mol. Wt. 183.32
M. P. 568°C
Density 4.047 @25°C
Vap. Press. 10 mm @656°C
Toxicity: See Cadmium Compounds.

CADMIUM COMPOUNDS
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Variable
Chronic Systemic: Ingestion 3; Inhalation 3
Toxicology: The inhalation of fumes or dusts of cadmium primarily affects the respiratory tract; the kidneys may also be affected. Even brief exposure to high concentrations may result in pulmonary edema and death. Usually the edema is not massive, with little pleural effusion. In fatal cases, fatty degeneration of the liver, and acute inflammatory changes in the kidneys have been noted. Ingestion of cadmium results in a gastrointestinal type of poisoning resembling food poisoning in its symptoms.

Inhalation of dust or fumes may cause dryness of the throat, cough, headache, a sense of constriction in the chest, shortness of breath (dyspnea) and vomiting. More severe exposure results in marked lung changes, with persistent cough, pain in the chest, severe dyspnea and prostration which may terminate fatally. X-ray changes are usually similar to those seen in broncho-pneumonia. The urine is frequently dark. These symptoms are usually delayed for some hours after exposure, and fatal concentrations may be breathed without sufficient discomfort to warn the workman to leave the exposure. See also Cadmium.

Ingestion of cadmium results in sudden nausea, salivation, vomiting and diarrhea and abdominal pain and discomfort. Symptoms begin almost immediately after ingestion.

A yellow discoloration of the teeth has been reported in workers exposed to cadmium. Cadmium oxide fumes can cause metal fume fever resembling that caused by zinc oxide fumes.

Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

CADMIUM CYANIDE

Description: Crystals.
Formula: $Cd(CN)_2$
Constants:
Mol. Wt. 164.45
M. P. > 200°C Decomposes
Toxicity: See Cyanides and Cadmium Compounds.

CADMIUM DI-HYDROGEN PHOSPHATE

Description: Triclinic crystals.
Formula: $Cd(H_2PO_4)_2 \cdot 2H_2O$
Constants: Mol. Wt. 342.4
M. P. Decomposes 100°C
Density 2.74 @15°/4°C
Toxicity: See Cadmium Compounds and Phosphoric Acid.

CADMIUM ETHYLENE BIS-DITHIOCARBAMATE

Toxicity: See Cadmium Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of cadmium and oxides of sulfur.
Storage and Handling: Section 7

CADMIUM FERROCYANIDE

Description: Solid.
Formula: $Cd_2Fe(CN)_6 \cdot xH_2O$
Constant:
Mol. Wt. 454.8
Toxicity: See Cadmium Compounds and Ferrocyanides.
Storage and Handling: Section 7

CADMIUM FLUOGALLATE

Description: Colorless crystals.
Formula: $(Cd(H_2O)_6)(GaF_5H_2O)$
Constants:
Mol. Wt. 403.24
M. P. $-5H_2O$ @110°C
Density 2.79
Toxicity: See Fluogallates and Cadmium Compounds.
Disaster Control: See Cadmium and Fluorides.
Storage and Handling: Section 7

CADMIUM FLUORIDE

Description: Cubic white crystals.
Formula: CdF_2
Constants:
Mol. Wt. 150.41
M. P. 1100°C
B. P. 1751°C
Density 6.64
Vap. Press. 1 mm @1112°C
Toxicity: See Fluorides and Cadmium Compounds.
Disaster Control: See Cadmium and Fluorides.
Storage and Handling: Section 7

CADMIUM FLUOSILICATE

Description: Hexagonal, colorless crystals.
Formula: $CdSiF_6 \cdot 6H_2O$
Constant:
Mol. Wt. 362.6
Toxicity: See Cadmium Compounds and Fluosilicates.
Disaster Control: See Cadmium and Fluorides.
Storage and Handling: Section 7

CADMIUM FORMATE

Description: Monoclinic crystals.
Formula: $Cd(CHO_2)_2 \cdot 2H_2O$
Constants: Mol. Wt. 238.48

M. P. Decomposes
Density 2.44
Toxicity: See Cadmium Compounds and Formic Acid.
Disaster Control: See Cadmium Compounds.
Storage and Handling: Section 7

CADMIUM FUMARATE

Description: Solid.
Formula: $CdC_4H_2O_4$
Constant:
Mol. Wt. 226.47
Toxicity: See Cadmium Compounds.
Disaster Control: See Cadmium
Storage and Handling: Section 7

CADMIUM HYDROGEN ARSENATE

Description: Solid.
Formula: $CdHAsO_4 \cdot H_2O$
Constants:
Mol. Wt. 270.34
Density 4.164 @15°/4°C
Toxicity: See Arsenic Compounds and Cadmium Compounds.
Disaster Control: See Arsenic and Cadmium.
Storage and Handling: Section 7

CADMIUM HYDROXIDE

Description: Trigonal or amorphous white crystals.
Formula: $Cd(OH)_2$
Constants:
Mol. Wt. 146.43
M. P. Decomposes 300°C
Density 4.79 @15°C
Toxicity: See Cadmium Compounds.

CADMIUM IODATE

Description: White crystals.
Formula: $Cd(IO_3)_2$
Constants:
Mol. Wt. 462.25
M. P. Decomposes
Density 6.43
Toxicity: See Cadmium Compounds and Iodates.
Fire Hazard: See Iodates.
Disaster Control: See Cadmium and Iodates
Storage and Handling: Section 7

CADMIUM IODIDE

Description: Hexagonal, brownish crystals.
Formula: CdI_2 (alpha): CdI_2 (beta)
Constants:
Mol. Wt. 366.25; 366.25
M. P. 385°C
B. P. 713°C
Density 5.670 @30°C
Vap. Press. 1 mm @416°C
Toxicity: See Cadmium Compounds and Iodides.

CADMIUM LACTATE

Description: Needles.
Formula: $Cd(C_2H_5O_3)_2$
Constant:
Mol. Wt. 290.55
Toxicity: See Cadmium Compounds.
Disaster Control: See Cadmium.
Storage and Handling : Section 7

CADMIUM MALEATE

Description: Solid.
Formula: $CdC_4H_2O_4 \cdot 2H_2O$
Constant:
Mol. Wt. 262.50
Toxicity: See Cadmium Compounds.
Disaster Control: See Cadmium.
Storage and Handling: Section 7

CADMIUM MOLYBDATE

Description: A solid.
Formula: $CdMoO_4$
Constants:
Mol. Wt. 272.36
Density 5.347
Toxicity: See Cadmium Compounds and Molybdenum Compounds.

CADMIUM NITRATE

Description: White, prismatic needles; hygroscopic.
Formula: $Cd(NO_3)_2$
Constants:
Mol. Wt. 236.43
M. P. 350°C
Toxicity: See Cadmium Compounds and Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Cadmium Compounds and Nitrates.
Storage and Handling: Section 7

CADMIUM NITROCOBALTATE (III)

Synonym: Cadmium cobaltinitrite.
Description: Yellow crystals.
Formula: $Cd_3(Co(NO_2)_6)_2$
Constants:
Mol. Wt. 1007.21
M. P. Decomposes 175°C
Toxicity: See Cadmium, Cobalt Compounds, and Nitrates.
Disaster Control: See Cadmium

and Nitrates.
Storage and Handling: Section 7

CADMIUM ORANGE. See Cadmium Selenide.

CADMIUM OXALATE
Description: Colorless crystals.
Formula: CdC_2O_4
Constants:
Mol. Wt. 200.43
M. P. Decomposes @340°C
Density 3.32 @18°/4°C
Toxicity: See Cadmium Compounds and Oxalates.

CADMIUM OXIDE
Description: (1) amorphous, brown crystals; (2) cubic, brown crystals.
Formula: CdO
Constants:
Mol. Wt. 128.41
M. P. (1) > 1426°C; (2) 900°C decomposes
B. P. 1559°C
Density (1) 6.95; (2) 8.15
Vap. Press. 1 mm @1000°C
Toxicity: See Cadmium Compounds.

CADMIUM PERCHLORATE
Description: Crystals.
Formula: $Cd(C1O_4)_2 \cdot 6H_2O$
Constants:
Mol. Wt. 419.9
M. P. 129.4°C
Toxicity: See Cadmium Compounds and Perchlorates.
Fire Hazard: See Perchlorates.
Explosion Hazard: See Perchlorates.
Disaster Control: See Cadmium and Perchlorates.
Storage and Handling: Section 7

CADMIUM PERMANGANATE
Description: Violet crystals.
Formula: $Cd(MnO_4)_2 \cdot 6H_2O$
Constants:
Mol. Wt. 458.4
M. P. Decomposes @95°C
Density 2.81
Toxicity: See Cadmium Compounds and Manganese Compounds.
Fire Hazard: See Permanganates.
Disaster Control: See Cadmium and Permanganates.
Storage and Handling: Section 7

CADMIUM ortho-PHOSPHATE
Description: Amorphous or colorless crystals.
Formula: $Cd_3(PO_4)_2$
Constants:
Mol. Wt. 527.19
M. P. 1500°C
Toxicity: See Cadmium Compounds.

CADMIUM PICRATE
Description: Yellow solid.
Formula: $Cd(C_6H(NO_2)_3OH)_2$
Constant:
Mol. Wt. 568.6
Toxicity: See Cadmium Compounds and Picrates.
Fire Hazard: See Picrates.
Explosion Hazard: See Picrates.
Disaster Control: See Cadmium and Picrates.
Storage and Handling: Section 7

CADMIUM POTASSIUM IODIDE
Synonym: Potassium cadmium iodide.
Description: White-yellowish crystals, powder, deliquescent.
Formula: $2KI.CdI_2 \cdot 2H_2O$
Constants:
Mol. Wt. 734.31
Density 3.359
Toxicity: See Cadmium Compounds and Iodides.

CADMIUM RED. See Cadmium Selenide.

CADMIUM RICINOLEATE
Description: Fine white powder.
Formula: $Cd[CO_2(CH_2)_7CH = CHCH_2CHOH(CH_2)_5CH_3]_2$
Constants:
Mol. Wt. 702.5
M. P. 103°C
Density 1.11 at 25°/25°
Toxicity: See Cadmium Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.
Storage and Handling: Section 7

CADMIUM SALICYLATE
Description: White needles.
Formula: $Cd(C_7H_5O_3)_2 \cdot H_2O$
Constant:
Mol. Wt. 404.65
Toxicity: See Cadmium Compounds.
Disaster Control: See Cadmium.
Storage and Handling: Section 7

CADMIUM SELENATE, DIHYDRATE
Description: Rhombic crystals.
Formula: $CdSeO_4 \cdot 2H_2O$
Constants:
  Mol. Wt. 291.40
  M. P. $-H_2O$ @100°C
  Density 3.632
Toxicity: See Cadmium Compounds and Selenium Compounds.
Disaster Control: See Cadmium and Selenium Compounds.
Storage and Handling: Section 7

CADMIUM SELENIDE
Description: Red powder, or it may be gray to brown.
Formula: CdSe
Constants:
  Mol. Wt. 191.37
  M. P. > 1350°C
  Density 5.81 @15°/4°C
Toxicity: See Cadium Compounds and Selenium Compounds.
Fire Hazard: Moderate when exposed to heat or flame (Section 6).
Caution: See Hydrogen Selenide which can be evolved on contact with acids or moisture.
Explosion Hazard: Moderate, when exposed to flame (Section 7).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of cadmium; it can emit hydrogen selenide and selenium compounds on contact with moisture, acid or acid fumes.
Storage and Handling: Section 7

CADMIUM meta-SILICATE
Description: Colorless, rhombic crystals.
Formula: $CdSiO_3$
Constants:
  Mol. Wt. 188.47
  M. P. 1242°C
  Density 4.93
Toxicity: See Cadmium Compounds and Silicates.

CADMIUM SOAP
Toxicity: See Cadmium Compounds.

CADMIUM SULFATE
Description: Rhombic, white crystals.
Formula: $CdSO_4$
Constants:
  Mol. Wt. 208.48
  M. P. 1000°C
  Density 4.691
Toxicity: See Cadmium Compounds.

CADMIUM SULFIDE
Synonym: Greenockite.
Description: Hexagonal, yellow-orange crystals.
Formula: CdS
Constants:
  Mol. Wt. 144.48
  M. P. 1750° @100 atm.
  B. P. Sublimes in N_2
  Density 4.82
Toxicity: See Cadmium Compounds and Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Cadmium and Sulfides.
Storage and Handling: Section 7

CADMIUM SULFITE
Description: Crystals.
Formula: $CdSO_3$
Constants:
  Mol. Wt. 192.48
  M. P. Decomposes
Toxicity: See Cadmium Compounds and Sulfites.
Disaster Control: See Cadmium and Sulfites.
Storage and Handling: Section 7

CADMIUM TARTRATE
Description: White, crystalline powder.
Formula: $CdC_4H_4O_6$
Constant:
  Mol. Wt. 260.48
Toxicity: See Cadmium Compounds.

CADMIUM TELLURIDE
Description: Black, cubic crystals.
Formula: CdTe
Constants:
  Mol. Wt. 240.02
  M. P. 1041°C
  Density 6.20 @15°C
Toxicity: See Cadmium Compounds and Tellurium Compounds.
Fire Hazard: Moderate when exposed to heat or flame (Section 6).
Caution: See Hydrogen Telluride which can be evolved on contact with acids or moisture.
Explosion Hazard: Moderate, when exposed to flame (Section 7).
Disaster Control: Dangerous; when heated to decomposition, it emits

highly toxic fumes of cadmium; it can emit hydrogen telluride and tellurium compounds on contact with acid or acid fumes, or moisture.

Storage and Handling: Section 7

CADMIUM TRICHLOROACETATE

Description: Rhombic crystals.
Formula: $Cd(C_2Cl_3O_2)_2 \cdot 1\frac{1}{2}H_2O$
Constants:
  Mol. Wt. 464.22
  Density 2.093 @ 25°C
Toxicity: See Cadmium Compounds and Trichloroacetic Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of cadmium and chlorides.
Storage and Handling: Section 7

CADMIUM TUNGSTATE

Description: Yellow crystals.
Formula: $CdWO_4$
Constant:
  Mol. Wt. 360.33
Toxicity: See Cadmium and Tungsten Compounds.

"CADMOLITH". See Barium Sulfate and Cadmium Sulfide.

CAFFEINE

Synonym: Theine.
Description: White, fleecy masses.
Formula: $C_8H_{10}N_4O_2 \cdot H_2O$
Constants:
  Mol. Wt. 212.11
  M. P. 236.8°C
Toxic Hazard Ratings:
  Acute Local: 0
  Acute Systemic: Ingestion 2
  Chronic Local: 0
  Chronic Systemic: Ingestion 2
Toxicology: Large doses (above 1.0 gram) cause palpitation, excitement, insomnia, dizziness, headache and vomiting. Continued excessive use of caffeine in tea or coffee may lead to digestive disturbances, constipation, palpitations, shortness of breath and depressed mental states.
Treatment and Antidotes: Evacuate stomach with emetic or stomach tube. Call a physician.
Fire Hazard: Slight, when heated to decomposition, it emits toxic fumes.

CALCIMINE

Description: A white powder.
Composition: Chalk and Glue.
Toxic Hazard Rating:
  Acute Local: Inhalation 1
  Acute Systemic: 0
  Chronic Local: Inhalation 1
  Chronic Systemic: 0
Ventilation Control (use optional): Section 2.

CALCITE. See Calcium Carbonate.

CALCIUM

Description: Silver-white, soft metal.
Formula: Ca
Constants:
  At. Wt. 40.08
  M. P. 842°C
  B. P. 1240°C
  Density 1.54 @ 20°C
  Vap. Press. 10 mm @ 983°C
Radiation Information: Artificial isotope Ca^{45}, half-life: 176 days; emits beta particles of 0.25 mev. The permissible levels are: In body: 65 microcuries. In air: 3×10^{-8} microcurie per milliliter. In water: 5×10^{-4} microcurie per milliliter. Ca^{45} has a high hazard rating because of its bone-seeking properties. The isotope is taken up very rapidly in the bone structure and may cause damage to the blood-forming organs. Hazard Rating, Class III (National Bureau of Standards Handbook No. 42).
Fire Hazard: Moderate, when heated or in intimate contact with oxidizing agents. Contact with moisture or acids evolves hydrogen. See also Hydrogen.
To Fight Fire: Special mixtures of dry chemical (Section 6).
Explosion Hazard: Moderate, in intimate contact with very powerful oxidizing agents (Section 7).
Disaster Control: Dangerous; reacts with moisture or acids to liberate large quantities of hydrogen; it can develop explosive pressure in containers. See also Hydrogen.
Ventilation Control (use optional): Section 2.
Personal Hygiene: Section 3
Storage and Handling: Section 7

Shipping Regulations: Section 11.
I.C.C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

CALCIUM ACRYLATE

Description: White crystals.
Formula: $Ca(CO_2CHCH_2)_2$
Constant:
Mol. Wt. 182
Toxicity: See Calcium Compounds.
Fire Hazard: Slight, when heated, it emits acrid fumes; it will react with water or steam to produce heat (Section 6).
Storage and Handling: Section 7

CALCIUM ACRYLATE DIHYDRATE

Description: White powder.
Formula: $(CH_2CHCOO)_2Ca \cdot 2H_2O$
Constant:
Mol. Wt. 218.22
Toxicity: See Calcium Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

CALCIUM ARSENATE

Synonyms: Tricalcium o-arsenate; calcium o-arsenate.
Description: White, amorphous powder.
Formula: $Ca_3(AsO_4)_2$
Constant:
Mol. Wt. 398.06
Toxicity: See Arsenic Compounds.
MAC: ACGIH (tentative); 0.3 milligrams per cubic meter of air.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

CALCIUM ARSENIDE

Description: Red crystals.
Formula: Ca_3As_2
Constants:
Mol. Wt. 270.06
M. P. Decomposes
Density 3.031 @ 25°C
Toxicity: See Arsenic Compounds and Arsine.
Fire Hazard: Moderate; on contact with moisture, acid, or acid fumes, it will evolve arsine. See also Arsine.
Explosion Hazard: Moderate; on contact with moisture, acid or acid fumes, it will evolve arsine. See also Arsine.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of arsenic; it will react with water, steam, acid or acid fumes to produce toxic and flammable vapors of arsine.
Storage and Handling: Section 7

CALCIUM ARSENITE

Description: White, granular powder.
Formula: $CaAsO_3H$
Constant: Mol. Wt. 164.00
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.
MCA warning label.

CALCIUM AZIDE

Description: Rhombic, colorless crystals.
Formula: $Ca(N_3)_2$
Constants:
Mol. Wt. 124.13
M. P. Explodes 144 - 156°C
Toxicity: See Azides
Explosion Hazard: See Azides.
Disaster Control: See Azides.
Storage and Handling: Section 7

CALCIUM BISULFITE

Description: Colorless or slightly yellowish liquid; strong sulfur dioxide odor.
Formula: $Ca(HSO_3)_2$
Constants:
Mol. Wt. 202.21
Density 1.06
Toxicity: See Bisulfites.
Disaster Control: See Bisulfites.
Storage and Handling: Section 7

CALCIUM meta-BORATE

Description: Colorless, rhombic or long, flat plates.
Formula: $Ca(BO_2)_2$
Constants:
Mol. Wt. 125.72
M. P. 1154°C
Toxicity: See Boron Compounds.

CALCIUM BORIDE

Description: Cubic, black crystals.
Formula: CaB_6
Constants:
  Mol. Wt. 105.00
  Density 2.3 @20°C
Toxicity: See Calcium Compounds.
Fire Hazard: Moderate; on contact with moisture, acid or acid fumes, it will evolve boron hydrides, some of which are highly toxic and flammable.
Storage and Handling: Section 7

CALCIUM BROMATE

Description: Monoclinic crystals.
Formula: $Ca(BrO_3)_2 \cdot H_2O$
Constants:
  Mol. Wt. 313.9
  M. P. $-H_2O$ @180°C
  Density 3.329
Toxicity: See Bromates.
Fire Hazard: See Bromates.
Disaster Control: See Bromates.
Storage and Handling: Section 7

CALCIUM BROMIDE

Description: Deliquescent needles.
Formula: $CaBr_2$
Constants:
  Mol. Wt. 199.91
  M. P. 765°C
  Density 3.353 @25°C
  B. P. 806 - 812°C
Toxicity: See Bromides.

CALCIUM CARBIDE

Description: Rhombic, gray crystals.
Formula: CaC_2
Constants:
  Mol. Wt. 64.10
  M. P. Approx. 2300°C
  Density 2.22
Toxicity: Acetylene is evolved when calcium carbide is in contact with moisture. See also Calcium Hydroxide and Acetylene.
Fire Hazard: Moderate; on contact with moisture, acid or acid fumes, it evolves heat or flammable vapors. See also Acetylene.
Explosion Hazard: Moderate. See also Acetylene.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  Coast Guard Classification: Hazardous Article

CALCIUM CARBONATE

Synonyms: Calcite; aragonite.
Description: White powder.
Formula: $CaCO_3$
Constants:
  Mol. Wt. 100.09
  M. P. Decomposes @825°C; 1339°C @1025 atm.
  Density 2.7 - 2.95
Toxicity: See Calcium Compounds.

CALCIUM CHLORATE

Description: Monoclinic, white-yellowish, deliquescent crystals.
Formula: $Ca(ClO_3)_2 \cdot 2H_2O$
Constants:
  Mol. Wt. 243.03
  M. P. $-H_2O > 100$°C
  Density 2.711
Toxicity: See Chlorates and Calcium Compounds.
Fire Hazard: See Chlorates.
Explosion Hazard: See Chlorates.
Disaster Control: See Chlorates.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Oxidizing material; yellow label.
  Coast Guard Classification: Oxidizing material; yellow label.

CALCIUM CHLORIDE

Description: Cubic colorless, deliquescent crystals.
Formula: $CaCl_2$
Constants: Mol. Wt. 110.99
  M. P. 772°C
  B. P. > 1600°C
  Density 2.512 @25°C
Toxicity: See Calcium Compounds.

CALCIUM CHLORIDE FLUORIDE ortho-PHOSPHATE

Description: Colorless crystals.
Formula: $CaClF \cdot 3Ca_3(PO_4)_2$
Constant:
  Mol. Wt. 1025.14
  M. P. 1270°C
  Density 3.14
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

CALCIUM CHLORIDE HYPOCHLORITE

Synonyms: Bleaching powder; chlorinated lime.
Description: White powder, strong

Cl odor; composition varies.
Formula:
$Ca(ClO)_2 \cdot CaCl_2 \cdot xCa(OH)_2 \cdot xH_2O$
Constant:
M. P. Decomposes
Toxicity: See Hypochlorites.
Explosion Hazard: See Hypochlorites.
Disaster Control: See Hypochlorites.
Storage and Handling: Section 7

CALCIUM CHLORITE

Description: White solid.
Formula: $CaClO_2$
Constant:
Mol. Wt. 107.6
Toxicity: See Chlorites.
Fire Hazard: See Chlorites.
Disaster Control: See Chlorites.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

CALCIUM CHROMATE

Description: Monoclinic prisms, yellow color.
Formula: $CaCrO_4 \cdot 2H_2O$
Constants:
Mol. Wt. 192.12
M. P. $-2H_2O$ @ 200 °C
Toxicity: See Chromium Compounds.
Fire Hazard: Slight, by reaction with reducing agents (Section 6).

CALCIUM COMPOUNDS

Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: Irritant 1
Chronic Systemic: U
Toxicology: The fumes evolved by burning calcium in air are composed of calcium oxide (quick lime). This material is irritating to the skin, eyes and mucous membranes. Many calcium compounds are used medicinally. Generally speaking, calcium compounds should be considered toxic only when they contain a toxic component (such as arsenic, etc.) or as calcium oxide or hydroxide.
Treatment and Antidotes: Any calcium residue left on the body or clothing should be brushed off immediately.

CALCIUM CYANAMIDE

Description: Hexagonal, rhombohedral, colorless cyrstals.
Formula: $CaCN_2$
Constants:
Mol. Wt. 80.11
M. P. 1300 °C; sublimes > 1500 °C
Toxicology: Calcium cyanamide acts locally on the skin as a primary irritant, and the lesions produced vary from erythema to acute and subacute eczema. Usually the moist skin areas are attacked first, but the material is spread by scratching and parts of the body not ordinarily exposed may be affected. In severe cases ulceration may develop; the ulcers are usually covered by a black, necrotic crust. There is frequently irritation of the conjunctivae and of the mucous membranes of the nose and throat, with production of conjunctivitis, inflamed ulcers in the nose and throat, rhinitis and gingivitis. Systemically, headache, flushing of the skin of the head and neck, shortness of breath, vasodilation with lowered blood pressure, and rapid pulse have been described among exposed persons who have consumed alcohol. No fatalities have been reported. Calcium cyanamide is not believed to have a cumulative action. The fatal dose, by ingestion, is probably around 20 to 30 grams for an adult.
Disaster Control: See Cyanides.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: (Not hydrated); hazardous article label.
Coast Guard Classification: Poison B; poison label.

CALCIUM CYANIDE

Description: Rhombohedran crystals; white powder.
Formula: $Ca(CN)_2$
Constants:
Mol. Wt. 92.12

M. P. Decomposes > 350°C
Toxicity: See Cyanides.
Fire Hazard: See Cyanides.
Explosion Hazard: See Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.
MCA warning label.

CALCIUM CYANOPLATINITE

Description: Rhombic, yellow-green fluorescent crystals.
Formula: $CaPt(CN)_4 \cdot 5H_2O$
Constant:
Mol. Wt. 429.46
Toxicity: See Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

CALCIUM DICYANOGUANIDINE

Description: Crystals.
Formula: $Ca(NH_2CN(NCN)CN)_2 \cdot 4H_2O$
Constants:
Mol. Wt. 328.3
M. P. > 300°C
Toxicity: Details unknown; may be toxic by skin absorption.
Disaster Control: See Cyanides.
Personal Hygiene: Section 3
Storage and Handling: Section 7

CALCIUM ETHYLENE BIS-DITHIOCARBAMATE

Description: Solid.
Formula: $Ca(C_2H_3)_2NCS_2)_2$
Constant:
Mol. Wt. 330.5
Toxicity: Details unknown; a fungicide.
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes.
Storage and Handling: Section 7

CALCIUM FERRICYANIDE

Description: Red, deliquescent needles.
Formula: $Ca_3(Fe(CN)_6)_2 \quad 12H_2O$
Constant:
Mol. Wt. 760.4
Toxicity: See Ferricyanides and Calcium Compounds.
Disaster Control: See Ferricyanides.
Storage and Handling: Section 7

CALCIUM FERROCYANIDE

Description: Yellow, triclinic crystals.
Formula: $Ca_2Fe(CN)_6 \cdot 11H_2O$
Constants:
Mol. Wt. 490.3
M. P. Decomposes
Density 1.68
Toxicity: See Calcium Compounds and Ferrocyanides.
Disaster Control: See Ferrocyanides.
Storage and Handling: Section 7

CALCIUM FLUORIDE

Description: Cubic, colorless crystals; luminous with heat.
Formula: CaF_2
Constants:
Mol. Wt. 78.1
M. P. 1360°C
Density 3.180
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

CALCIUM FLUOSILICATE

Description: White, crystalline powder.
Formula: $CaSiF_6$
Constants:
Mol. Wt. 182.14
Density 2.662 @17.5°C
Toxicity: See Fluosilicates.
Disaster Control: See Fluosilicates.
Storage and Handling: Section 7

CALCIUM HYDRATE. See Calcium Hydroxide.

CALCIUM HYDRIDE

Synonym: Hydrolith
Description: Gray-white crystal; powder.
Formula: CaH_2
Constants:
Mol. Wt. 42.10
M. P. 816°C in H; decomposes @about 600°C
Density 1.8 approx.
Toxicity: See Calcium Compounds and Hydrides. Reacts with moisturn to form calcium hydroxide and hydrogen. Aside from its reducing action, its effect is as of calcium hydroxide.
Fire Hazard: See Hydrides.
Explosion Hazard: See Hydrides.
Disaster Control: See Hydrides.
Storage and Handling: Section 7

CALCIUM HYDROGEN SULFITE.
See Calcium Bisulfite.

CALCIUM HYDROXIDE
Synonyms: Hydrated lime; slaked lime.
Description: Rhombic, trigonal, colorless crystals.
Formula: $Ca(OH)_2$
Constants:
Mol. Wt. 74.10
M. P. $-H_2O$ @580°C
B. P. Decomposes
Density 2.343
Toxicity: See Calcium Compounds.
Toxicology: Calcium hydroxide has a caustic reaction and therefore is irritating to the skin and respiratory system. In the form of dust it is considered to be an important industrial hazard. It can cause dermatitis, irritation of the eyes and mucous membranes (Section 9).
Treatment and Antidotes: Irrigate any areas which have come in contact with this material. If the eyes are involved, they should be washed at once with copious amounts of warm water. If the skin is involved, a shower is recommended. See also Calcium Compounds.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

CALCIUM HYPOCHLORITE
Description: Tetragonal crystals.
Formula: $Ca(ClO)_2 \cdot 2H_2O$
Constants:
Mol. Wt. 178.9
M. P. $-H_2O$ @74°C
Toxicity: See Hypochlorites.
Fire Hazard: See Hypochlorites.
Disaster Control: See Hypochlorites.
Storage and Handling: Section 7

CALCIUM HYPOCHLORITE COMPOUNDS, DRY, CONTAINING MORE THAN 8.80% AVAILABLE OXYGEN, 39% AVAILABLE CHLORINE.
See Hypochlorites.
Shipping Regulations: Section 11.
I.C.C. Classification: Oxidizing material: yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

CALCIUM IODATE
Synonym: Autarite.
Description: Triclinic crystals.
Formula: $Ca(IO_3)_2$
Constants:
Mol. Wt. 389.9
M. P. Decomposes
Density 4.519 @15°C
Toxicity: See Iodates and Calcium Compounds.
Fire Hazard: See Iodates.
Caution: A powerful oxidizing agent.
Disaster Control: See Iodates.
Storage and Handling: Section 7.

CALCIUM NITRATE
Description: Cubic, colorless, hygroscopic crystals.
Formula: $Ca(NO_3)_2$
Constants:
Mol. Wt. 164.10
M. P. 561°C
Density 2.36
Toxicity: See Nitrates and Calcium Compounds.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material.

CALCIUM NITRIDE
Description: Brown crystals.
Formula: Ca_3N_2
Constants:
Mol. Wt. 148.3
M. P. 900°C
Density 2.63 @17°C
Toxicity: See Calcium Compounds and Ammonia.
Fire Hazard: See Ammonia.
Caution: Ammonia can be evolved upon contact with moisture.
Explosion Hazard: See Ammonia.
Disaster Control: See Ammonia.
Storage and Handling: Section 7

CALCIUM NITRITE
Description: Hexagonal, colorless to yellowish crystals.
Formula: $Ca(NO_2)_2 \cdot H_2O$
Constants:
Mol. Wt. 150.11
M. P. $-H_2O$ @100°C
Density 2.23 @34°C (anh.); 2.53 @30°C
Toxicity: See Nitrites and Calcium Compounds.

Fire Hazard: See Nitrites.
Disaster Control: See Nitrites.
Storage and Handling: Section 7

CALCIUM OXALATE
Description: Cubic, colorless crystals.
Formula: CaC_2O_4
Constants:
Mol. Wt. 128.10
M. P. Decomposes
Density 2.2 @4°C
Toxicity: See Oxalates and Calcium Compounds.

CALCIUM OXIDE
Synonyms: Unslaked lime; quicklime; burnt lime; calx.
Description: Cubic, colorless crystals.
Formula: CaO
Constants:
Mol. Wt. 56.08
M. P. 2580°C
B. P. 2850°C
Density 3.37
Toxicity: See Calcium Hydroxide.
Disaster Control: Slightly dangerous; on contact with water, steam, acid or acid fumes, it will react to produce heat.
Storage and Handling: Section 7

CALCIUM PERCHLORATE
Description: Colorless crystals.
Formula: $Ca(ClO_4)_2$
Constant:
Mol. Wt. 238.09
Toxicity: See Perchlorates and Calcium Compounds.
Fire Hazard: See Perchlorates.
Explosion Hazard: See Perchlorates.
Disaster Control: See Perchlorates.
Storage and Handling: Section 7

CALCIUM PERMANGANATE
Synonym: Acerdol.
Description: Violet, deliquescent crystals.
Formula: $Ca(MnO_4)_2 \cdot 5H_2O$
Constant:
Mol. Wt. 368.02
M. P. Decomposes
Density 2.4
Toxicity: See Manganese and Calcium Compounds.
Fire Hazard: See Permanganates.
Disaster Control: See Permanganates.
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

CALCIUM PEROXIDE
Synonym: Calcium superoxide.
Description: Yellow crystals, powder or white crystals.
Formula: CaO_2
Constants: Mol. Wt. 72.08
M. P. Decomposes 275°C
Toxicology: Although this material is used in dentifrices, the concentrated form would be an irritant. It would react with moisture to form slaked lime. See also Calcium Compounds, Calcium Hydroxide and Peroxides, Inorganic.
Fire Hazard: Moderate, if hot and mixed with finely divided combustible material. Decomposes rapidly above 200°C. Like calcium oxide, it is a strong alkali. An oxidizer. See also Peroxides, Inorganic.
Explosion Hazard: An explosion hazard when intimately mixed with finely divided reducing agents such as organic matter (Section 7).
Disaster Control: See Peroxides, Inorganic.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

CALCIUM 1-PHENOL-4-p-SULFONATE
Description: White to pinkish powder.
Formula: $Ca[C_6H_4(OH)SO_3]_2 \cdot H_2O$
Constant: Mol. Wt. 404.43
Toxicity: See Phenol Sulfonates.
Disaster Control: See Phenol Sulfonates.
Storage and Handling: Section 7

CALCIUM PHENOXIDE
Synonym: Calcium phenate.
Description: Powder.
Formula: $Ca(OC_6H_5)_2$
Constant: Mol. Wt. 226.28
Toxicity: See Phenol.
Disaster Control: See Phenol.
Storage and Handling: Section 7

CALCIUM PHOSPHATE, TRIBASIC
Synonyms: Bone ash; tricalcium phosphate.
Description: Amorphous, odorless powder.
Formula: $Ca_3(PO_4)_2$
Constants:
  Mol. Wt. 310.2
  M. P. 1670°C
  Density 3.14
Toxicity: See Calcium Compounds.

CALCIUM PHOSPHIDE
Description: Red crystals.
Formula: Ca_3P_2
Constants:
  Mol. Wt. 182.2
  M. P. > 1600°C
  Density 2.238 @25°C
Toxicity: See Phosphides.
Fire Hazard: See Phosphides.
Explosion Hazard: See Phosphides.
Disaster Control: See Phosphides.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid; yellow label.

CALCIUM o-PLUMBATE
Description: Reddish-brown crystals.
Formula: Ca_2PbO_4
Constants:
  Mol. Wt. 351.37
  M. P. Decomposes
  Density 5.71
Toxicity: See Lead Compounds.
Fire Hazard: See Lead Compounds.
Disaster Control: See Lead Compounds.
Storage and Handling: Section 7

CALCIUM POLYSULFIDES. See Calcium Sulfide.

CALCIUM RESINATE
Description: Yellowish white, amorphous powder or lumps.
Formula: $Ca(C_{44}H_{62}O_4)_2$
Constant:
  Mol. Wt. 1349.50
Toxicity: Unknown
Fire Hazard: Slight; when heated, it can react with oxidizing materials (Section 6).
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid; yellow label.

CALCIUM RESINATE, FUSED
See Calcium Resinate.
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid; yellow label.

CALCIUM RICINOLEATE
Description: Fine, white powder.
Formula: $Ca[CO_2(CH_2)_7CHCHCH_2CHOH(CH_2)_5CH_3]_2$
Constants:
  Mol. Wt. 630
  M. P. 84°C
  Density 1.09 @25°C
Toxicity: See Calcium Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

CALCIUM SELENATE
Description: Colorless crystals.
Formula: $CaSeO_4$
Constants:
  Mol. Wt. 183.04
  Density 2.93
Toxicity: See Selenium Compounds.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

CALCIUM SELENIDE
Description: Simple cubic crystals.
Formula: CaSe
Constants:
  Mol. Wt. 119.04
  Density 7.593
Toxicity: See Selenium Compounds.
Fire Hazard: Moderate, when heated. See Hydrogen Selenide, which can be evolved on contact with acids or moisture (Section 6).
Explosion Hazard: Moderate, when exposed to flame (Section 7).
Disaster Control: Dangerous; it can emit highly toxic and flammable fumes of hydrogen selenide of

selenium compounds on contact with water, steam, acid or acid fumes.
Storage and Handling: Section 7

CALCIUM SILICIDE
Description: Glassy solid.
Formula: $CaSi_2$
Constants:
  Mol. Wt. 96.2
  Density 2.5
Toxicity: See Calcium Hydroxide.
Fire Hazard: See Silane.
Explosion Hazard: See Silane.
Disaster Control: On contact with water or steam, it will react to produce flammable vapors of silane.
Storage and Handling: Section 7

CALCIUM SILICOFLUORIDE. See Fluosilicates.

CALCIUM SULFHYDRATE
Synonym: Calcium hydrosulfide.
Description: Colorless, transparent crystals; decomposes in air.
Formula: $Ca(HS)_2$
Constant:
  Mol. Wt. 106.21
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

CALCIUM SULFIDE
Synonyms: Oldhamite; hepar calcis; calcic liver of sulfur.
Description: Cubic, colorless crystals.
Formula: CaS
Constants:
  Mol. Wt. 72.14
  B. P. Decomposes
  Density 2.18 @15°C
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

CALCIUM SULFITE
Description: Hexagonal, colorless crystals.
Formula: $CaSo_3 \cdot 2H_2O$
Constants:
  Mol. Wt. 156.18
  M. P. $-2H_2O$ @100°C
Toxicity: See Sulfites.
Disaster Control: See Sulfites.
Storage and Handling: Section 7

CALCIUM SUPERPHOSPHATE
Synonym: Calcium triorthophosphate (fertilizer grade)
Description: Amorphous, white powder.
Formula: $Ca_3(PO_4)_2$
Constants:
  Mol. Wt. 310.28
  M. P. 1670°C
  Density 3.14
Toxicity: See Calcium Compounds and Phosphates.

CALCIUM TELLURIDE
Description: Simple cubic crystals.
Formula: CaTe
Constants:
  Mol. Wt. 167.69
  Density 7.593
Toxicity: See Tellurium Compounds.
Fire Hazard: Moderate, when heated. See Hydrogen Telluride, which can be evolved on contact with acids or moisture (Section 6).
Explosion Hazard: Slight, when exposed to flame.
Disaster Control: Dangerous; it emits highly toxic and flammable fumes of hydrogen telluride and tellurium compounds on contact with water, steam, acid or acid fumes.
Storage and Handling: Section 7

CALCIUM TELLURITE
Description: White flakes.
Formula: $CaTeO_3$
Constants:
  Mol. Wt. 215.69
  M. P. > 960°C
Toxicity: See Tellurium Compounds.
Disaster Control: See Tellurium Compounds.
Storage and Handling: Section 7

CALCIUM TETRABORATE
Description: White solid.
Formula: CaB_4O_7
Constants:
  Mol. Wt. 195.36
  M. P. 986°C
Toxicity: See Boron Compounds.

CALCIUM THIOCYANATE
Description: White crystals,

deliquescent.
Formula: $Ca(SCN)_2 \cdot 3H_2O$
Constant:
Mol. Wt. 210.30
Toxicity: See Thiocyanates.
Disaster Control: See Thiocyanates.
Storage and Handling: Section 7

CALOMEL. See Mercurous Chloride.

CAMPHENE

Synonym: 3, 3-Dimethyl-2-methylene norcamphone.
Description: Cubic crystals.
Formula: $C_{10}H_{16}$
Constants:
Mol. Wt. 136.2
M. P. 50 - 51°C
B. P. 159°C
Density 0.842 @54°/4°C
Toxicity: Unknown
Fire Hazard: Slight, yields flammable vapors when heated; it can react with oxidizing materials (Section 6).
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Hazardous article.

CAMPHOR

Synonyms: 2-camphonone; gum camphor; laurel camphor.
Description: White, transparent, crystalline masses, pentrating odor, pungent, aromatic taste.
Formula: $C_{10}H_{16}O$
Constants:
Mol. Wt. 152.23
M. P. 174 - 177°C
B. P. 204°C
Flash P. 150°F (C.C.)
Density 0.992 @25°/4°C
Autoign. Temp. 871°F
Vap. D. 5.24
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 1; Ingestion 2
Acute Systemic: Ingestion 2
Chronic Local: Allergen 1
Chronic Systemic: U
Toxicology: Locally, camphor is an irritant. When swallowed it causes nausea, vomiting, dizziness, excitation and convulsions.
Treatment and Antidotes: Evacuate stomach with emetic or stomach tube. Give sedatives if necessary. Call a physician.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, in the form of vapor when exposed to heat or flame (Section 7).
Explosive Range: 0.6 - 3.5%
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Hazardous article.

CAMPHOR OIL (LIGHT)

Synonym: Liquid camphor.
Description: An oily, fragrant liquid.
Constants:
B. P. 347 - 392°F
Flash P. 117°F (C.C.)
Density 0.88
Toxicity: See Camphor.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Combustible liquid.

CANADA BALSAM

Synonyms: Canada turpentine; balm of Gilead.
Description: Yellowish to greenish viscid, transparent, fluorescent, aromatic liquid.
Constant:
Density 0.987-0.994
Toxic Hazard Rating;
Acute Local: Irritant 1; Allergen 1; Ingestion 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Personal Hygiene: Section 3

CANNABIS

Synonyms: Cannabin resin; Indian hemp; Indian cannabis; hashish; guaza; marihuana.
Description: A resinous, bitter

substance from Cannabis Sativa, greenish black mass.

Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: Inhalation 2
  Chronic Local: Allergen 1
  Chronic Systemic: Inhalation 2

Toxicology: Cannabis is a narcotic; it causes the pupils to be widely dilated and to barely react to light. The eyes become glazed and the conjunctiva congested. Like the other narcotics, this material can be habit-forming. It can be grown in the temperate zones and acquired illegally for narcotic purposes.

Treatment and Antidotes: Removal from exposure or cessation of ingestion of this material will generally cause the symptoms to disappear. In case of a large dose, or if overdose is suspected, a physician should be consulted at once.

Fire Hazard: Slight, because the dried material can burn; it can react with oxidizing materials (Section 6).

Ventilation Control (use normal rate): Section 2

Storage and Handling: Section 7

CANNON PRIMERS. See Explosives, Low and High.

Shipping Regulations: Section 11.
  I.C.C. Classification: Explosive C
  Coast Guard Classification: Explosive C

CANTHARIDES

Synonyms: Blistering flies; blistering beetles; Spanish fly.

Description: Brown to black powder and scales.

Formula: $C_{10}H_{12}O_4$

Constants:
  Mol. Wt. 196.15
  M. P. 218°C
  B. P. Sublimes @90°C

Toxic Hazard Rating:
  Acute Local: Irritant 3; Allergen 1; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3
  Chronic Local: Irritant 3; Allergen 1
  Chronic Systemic: Ingestion 3

Toxicology: Extremely irritating to the eyes. Can cause conjunctivitis, keratitis, blepharitis, slight swelling of cornea and inflammation of iris. It is a powerful irritant. Used externally chiefly as a blistering agent. It is often and mistakenly used as an aphrodisiac, but is much too dangerous and irritant a material for this purpose. Symptoms of intoxication are extreme irritation of intestines and kidneys.

Treatment and Antidotes: If it has been ingested, a stomach syphon is recommended, or emetics, demulcents but not oils. Administer morphine, stimulants or poultices to the abdomen. Call a physician.

Disaster Control: Slight; on decomposition it emits toxic fumes.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

CAPROIC ACID

Synonym: Hexanoic acid.

Description: Colorless liquid, odor of limburger cheese.

Formula: $C_6H_{12}O_2$

Constants:
  Mol. Wt. 116.2
  B. P. 205.0°C
  Freezing P. −5.4°C
  Flash P. 215°F (C.O.C.)
  Density 0.9295 @20°/20°C
  Vap. Press. 0.18 mm @20°C
  Vap. D. 4.0

Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 1; Inhalation 1
  Chronic Local: U
  Chronic Systemic: U

Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical, or carbon tetrachloride (Section 6).

Ventilation Control (use optional); Section 2

Personal Hygiene: Section 3

Storage and Handling: Section 7

ε-CAPROLACTANE
Synonym: 2-Oxohexamethylenimine.
Description: White crystals.
Formula: $C_6N_{11}NO$
Constants:
Mol. Wt. 113.16
M. P. 69°C
Vap. Press. 6 mm @120°C
Toxicity: May be an irritant.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

CAPRYL ALCOHOL
Synonym: 2-Octanol.
Description: Clear, colorless, oily liquid, pungent, aromatic odor.
Formula: $CH_3HCOH(CH_2)_5CH_3$
Constants:
Mol. Wt. 130.2
B. P. 178.5°C
Freezing P. −38.6°C
Density 0.8193 @25°/4°C
Vap. D. 4.48
Toxicity: See Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
Storage and Handling: Section 7

CAPRYLYL CHLORIDE
Synonym: Octanoyl chloride.
Description: Clear, water-white to straw-colored liquid.
Formula: $CH_3(CH_2)_6COCl$
Constants: Mol. Wt. 162.7
M. P. −6°C
B. P. 195.5°C
Flash P. 180°F (C.C.)
Density 0.9576 @15.5°/15.5°C
Vap. D. 5.63
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene; it will react with water or steam to produce toxic and corrosive fumes; it can react vigorously with oxidizing materials.
Storage and Handling: Section 7

CAPRYLYL PEROXIDE SOLUTION
Toxicity: See Peroxides, Organic.
Fire Hazard: See Peroxides, Organic.
Disaster Control: See Peroxides, Organic.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

CAPSICUM
Synonym: Tincture of Tabasco Pepper.
Description: An alcoholic solution of Capsicum.
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3
Acute Systemic: Ingestion 3
Chronic Local: Irritant 3
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat. See also Alcohol.
Disaster Control: See Alcohol.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

CARBAMIDE
Synonym: Urea crystal.
Description: White crystals.
Formula: $(NH_2)_2CO$
Constants: Mol. Wt. 60.1
M. P. 132.7°C
B. P. Decomp.
Density (solid) 1.335
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Ingestion 1; Inhalation 1
Chronic Local: 0
Chronic Systemic: Ingestion 1
Carbamides have been used therapeutically for their mild sedative effect.
Disaster Control: Dangerous; when heated, it emits highly toxic fumes of cyanides; it can react with oxidizing materials.
Ventilation Control (use optional): Section 2
Storage and Handling: Section 7

CARBAMIDE PHOSPHORIC ACID
Description: White crystals.

Formula: $CO(NH_2)_2 \cdot H_3PO_4$
Constant:
  Mol. Wt. 158
Toxicity: See Phosphoric Acid and Carbamide.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of cyanides or oxides of phosphorus.
Storage and Handling: Section 7

CARBAMYL CHLORIDE

Synonym: Chloroformamide.
Description: Liquid, offensive odor.
Formula: H_2NCOCl
Constants:
  Mol. Wt. 79.5
  M. P. 50°C (approx.)
  B. P. 61 - 62°C (Decomp.)
Toxicity: See Hydrochloric Acid which is evolved upon standing.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene.
Storage and Handling: Section 7

CARBAZOLE

Synonym: Dibenzopyrrole.
Description: White crystals.
Formula: $(C_6H_4)_2NH$
Constants:
  Mol. Wt. 167.20
  M. P. 244.8°C
  B. P. 354.8°C
  Density 1.10 @18°/4°C
  Vap. Press. 400 mm @323.0°C
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight; on decomposition it emits toxic fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

"CARBITOL"

Synonym: Diethylene glycol monoethyl ether.
Description: Colorless liquid; mild pleasant odor.
Formula: $C_2H_5OCH_2CH_2OCH_2CH_2OH$
Constants:
  Mol. Wt. 134.17
  B. P. 201.9°C
  Flash P. 205°F (O.C.)
  Density 0.9902 @20°/4°C
  Vap. D. 4.62
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 3
  Chronic Local: U
  Chronic Systemic: Ingestion 1; Inhalation 1; Skin Absorption 1
Fire Hazard: Moderate, when exposed to heat; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical, or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

"CARBITOL" ACETATE

Synonym: Diethylene glycol monoethyl ether acetate.
Description: Liquid.
Formula: $C_2H_5O(CH_2)_2O(CH_2)_2OOCH_3$
Constants: Mol. Wt. 176.21
  B. P. 217.4°C
  Freezing P. −25°C
  Flash P. 225°F (C.C.)
  Density 1.0114 @20°/20°C
  Vap. Press. 0.05 mm @20°C
  Vap. D. 6.07
Toxicity: See Glycols.
Fire Hazard: Moderate, when exposed to heat; it can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

"CARBITOL" PHTHALATE

Synonym: Dicarbitol phthalate.
Description: Liquid.
Formula: $C_6H_4(COOC_2H_4OC_2H_4OC_2H_5)_2$
Constants:
  Mol. Wt. 398.44
  B. P. 200 - 260°C
  Flash P. 405°F (C.C.)
  Density 1.121
Toxicity: See Glycols.
Fire Hazard: Slight, when exposed to heat; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water, foam, carbon dioxide, dry chemical, or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

CARBOLIC ACID, LIQUID (LIQUID TAR ACID CONTAINING OVER 50% BENZOPHENOL). See Phenol.
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

CARBOLIC ACID, SOLID. See Phenol.
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

CARBON
Description: Black crystals, powder or diamond form.
Formula: C
Constants:
At. Wt. 12.01
M. P. 3652 - 3697°C (sublimes)
B. P. Approx. 4200°C
Density Amorphous 1.8 - 2.1; graphite 2.25; diamond 3.51
Vap. Press. 1 mm @3586°C
Toxic Hazard Rating:
Acute Local: Inhalation 1
Acute Systemic: 0
Chronic Local: Irritant 1
Chronic Systemic: 0
Toxicology: In the form of graphite (which is one of the common forms of carbon) it can cause a dust irritation, particularly to the eyes. Carbon in the form of soot can cause conjunctivitis. It can also cause epithelial hyperplasia of cornea, as well as eczematous inflammation of eyelids.
Treatment and Antidotes: If the toxic symptoms become pronounced, a physician should be consulted. Otherwise, removal from exposure will generally cause these symptoms to subside.
Radiation Hazard (Section 5): Natural isotope C^{14}, half life: 5600 years; emits beta particles of 0.155 mev. The permissible levels are: In body: 250 microcuries. In air: 10^{-6} microcurie per milliliter. In water: 3×10^{-3} microcurie per milliliter. C^{14} occurs in nature as a result of cosmic ray action. The activity is equivalent of 12.5 disintegrations per minute per gram of carbon for living things. Hazard Rating, Class II (National Bureau of Standards Handbook No. 42).
Fire Hazard: Slight, when exposed to heat (Section 6).
Explosion Hazard: Slight, in the form of dust when exposed to heat or flame (Section 7).
Shipping Regulations: Section 11.
Coast Guard Classification: Oxidizing materials.

CARBON, ACTIVATED. See Carbon.
Shipping Regulations: Section 11.
Coast Guard Classification: Oxidizing material.

CARBON DICHLORIDE. See Tetrachloroethylene.

CARBON DIOXIDE
Synonyms: Carbonic acid; carbonic anhydride.
Description: Colorless, odorless gas.
Formula: CO_2
Constants;
Mol. Wt. 44.01
M. P. −57.7°C (sublimes)
B. P. −78.2°C
Vap. D. 1.53
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Inhalation 1
Chronic Local: 0
Chronic Systemic: Inhalation 1
MAC: ACGIH (accepted); 5000 parts per million in air; 9000 milligrams per cubic meter of air.
Toxicology: Carbon dioxide is generally regarded as a simple asphyxiant, symptoms resulting only when such high concentrations are reached that there is insufficient oxygen in the atmosphere to support life. The signs and symptoms are those which precede asphyxia, namely, headache, dizziness, shortness of breath, muscular weakness, drowsiness, and ringing in the ears. Removal from exposure results in rapid recovery. Contact of carbon dioxide snow with the skin may cause a "burn." See also discussion of simple asphyxiants under Argon.
Disaster Control: Slightly dangerous; shock can shatter the compressed

gas container with explosive force.
Ventilation Control (use normal rate): Section 2
Shipping Regulations: Section 11.
I. C. C. Classification: Nonflammable gas; green label.
Coast Guard Classification: Nonflammable gas; green gas label.

CARBON DIOXIDE-NITROUS OXIDE MIXTURE

Description: Gas.
Composition $CO_2 + N_2O$
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Inhalation 2
Chronic Local: 0
Chronic Systemic: Inhalation 1
Ventilation Control (use normal rate): Section 2
Shipping Regulations: Section 11.
I. C. C. Classification: Nonflammable gas; green label.
Coast Guard Classification: Nonflammable gas; green gas label.

CARBON DIOXIDE-OXYGEN MIXTURE

Description: Gas.
Composition: $CO_2 + O_2$
Toxicity: None
Fire Hazard: Slight (Section 6).
Caution: An oxidizing mixture.
Disaster Control: Moderately dangerous; shock can shatter the compressed gas container with explosive force; it can react with reducing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Nonflammable gas; green label.
Coast Guard Classification: Nonflamamble gas; green gas label.

CARBON DIOXIDE, SOLID

Synonym: Dry Ice.
Description: White, snow-like solid.
Formula: CO_2
Constants:
Mol. Wt. 44
M. P. −56.6°C @ 5.2 atmospheres (sublimes)
B. P. −78.5°C
Density 1.56 @ 70°C
Toxic Hazard Rating:
Acute Local: Irritant 3
Acute Systemic: 0
Chronic Local: 0
Chronic Systemic: 0
Ventilation Control (use normal rate): Section 2
Shipping Regulations: Section 11.
Coast Guard Classification: Hazardous article.
MCA warning label.

CARBON DISELENIDE

Description: Greenish-yellow liquid.
Formula: CSe_2
Constants:
Mol. Wt. 169.9
B. P. 90°C (approx.)
Toxicity: Probably highly toxic. See Selenium Compounds and Carbon Disulfide.

CARBON DISULFIDE

Synonym: Carbon bisulfide.
Description: Clear, colorless liquid, nearly odorless when pure.
Formula: CS_2
Constants:
Mol. Wt. 76.1
M. P. −110.8°C
B. P. 46.5°C
Flash P. −22°F (C. C.)
Density 1.261 @ 20°/20°C
Autoign. Temp. 257°F
Vap. Press. 400 mm @ 28°C
Vap. D. 2.64
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
MAC: ACGIH (accepted); 20 parts per million in air; 62 milligrams per cubic meter of air.
Toxicology: The chief toxic effect is on the central nervous system, acting as a narcotic and anesthetic in acute poisoning with death following from respiratory failure. The anesthetic action is much more powerful than that of chloroform. In chronic poisoning, the effect on the nervous system is one of central and peripheral damage, which may be permanent

if the damage has been severe. Sensory symptoms usually precede motor involvement. A secondary anemia may be present, and the liver, kidneys and heart may be damaged.

In acute poisoning, early excitation of the central nervous system resembling alcoholic intoxication occurs, followed by depression, with stupor, restlessness, unconsciousness, and possibly death. If recovery occurs, the patient usually passes through the after-stage of narcosis, with nausea, vomiting, headache, etc. In chronic poisoning, the picture is that of involvement of the nervous system, with neuritis and disturbance of vision being the commonest early changes. Sensory changes, such as a crawling sensation in the skin, sensations of heaviness and coldness, and visually, "veiling" of objects so that they appear indistinct, are noticed first. Often there is pain in the affected parts, particularly the limbs. These symptoms are followed by gradually increasing loss of strength. Wasting of the muscles may occur. Mental symptoms vary from simple excitation or depression and irritability in the mild cases to mental deterioration, Parkinsonian paralysis, and even insanity. These changes are accompanied by insomnia, loss of memory, and personality changes. Chronic fatigue is a very common complaint.

Fire Hazard: Highly dangerous when exposed to heat, flame, sparks or friction.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Severe, when exposed to heat or flame (Section 7).
Explosive Range: 50%
Disaster Control: Highly dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; it can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11
  I. C. C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Inflammable liquid; red label
  MCA warning label.

CARBONIC ACID. See Carbon Dioxide.

CARBONITES. See Explosives, High.

CARBON MONOSULFIDE

Description: Red powder.
Formula: CS(or $(CS)_x$)
Constants:
  Mol. Wt. 44.08
  M. P. Decomposes 200°C
  Density 1.66
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.

CARBON MONOXIDE

Description: Colorless, odorless gas.
Formula: CO
Constants:
  Mol. Wt. 28.01
  M. P. -207°C
  B. P. -191.3°C
  Density (Gas) 1.250 grams per liter @0°C; (liquid) 0.793
  Autoign. Temp. 1204°C
  Vap. D 0.96
Toxic Hazard Rating:
  Acute Local: 0
  Acute Systemic: Inhalation 3
  Chronic Local: 0
  Chronic Systemic: Inhalation 1

Toxicology: Carbon monoxide has an affinity for hemoglobin 210 times that of oxygen, and by combining with the hemoglobin, renders the latter incapable of carrying oxygen to the tissues. The effect on the body is therefore predominantly one of asphyxia. In addition to this action, the presence of CO-hemoglobin in the blood interferes with the dissociation of the remaining oxyhemoglobin, so that the tissues are further deprived of oxygen.

A concentration of 400 to 500 ppm in the air can be inhaled without appreciable effect for 1 hour. An hour's exposure to 600 to 700 ppm will cause barely appreciable effects, and a similar exposure to 1,000 to 1,200 ppm is dangerous; concentrations of 4,000 ppm and over are fatal in less than an hour.

Carbon monoxide is eliminated through the lungs when air free from CO is inhaled. Over half the CO is eliminated in the first hour, where the exposure has been moderate.

With concentrations up to 10% of CO-hemoglobin in the blood, there rarely are any symptoms. Concentrations of 20 to 30% cause shortness of breath on moderate exertion and slight headache. Concentrations from 30 to 50% cause severe headache, mental confusion and dizziness, impairment of vision and hearing, and collapse and fainting on exertion. With concentrations of 50 to 60%, unconsciousness results, and death may follow if exposure is long. Concentrations of 80% result in almost immediate death.

Acute cases of poisoning, resulting from brief exposures to high concentrations, seldom result in any permanant disability if recovery takes place. Chronic effects as the result of repeated exposure to lower concentrations have been described, particularly in the Scandinavian literature. Auditory disturbances and contraction of the visual fields have been demonstrated. Glycosuria does occur, and heart irregularities have been reported. Other workers have found that where the poisoning has been relatively long and severe, cerebral congestion and edema may occur, resulting in long-lasting mental or nervous damage. Repeated exposure to low concentrations of the gas, up to 100 ppm in air, is generally believed to cause no signs of poisoning or permanent damage. Industrially, sequelae are rare, as exposure though often severe, is usually brief.

MAC: ACGIH (accepted); 100 parts per million in air; 115 milligrams per cubic meter of air.

Fire Hazard: Dangerous, when exposed to flame.

Spontaneous Heating: No

To Fight Fire: Carbon dioxide, dry chemical or water spray (Section 6).

Explosion Hazard: Severe, when exposed to heat or flame (Section 7).

Explosive Range 12.5 - 74.2%

Disaster Control: Highly dangerous; can shatter the compressed gas container with explosive force; when heated to decomposition, it emits toxic fumes; it can react vigorously with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Storage and Handling: Section 7

Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable gas; red gas label.
  Coast Guard Classification: Flammable gas; red gas label.

CARBON OXYCHLORIDE. See Phosgene.

CARBON OXYSULFIDE

Synonym: Carbonyl sulfide.

Description: Gas or liquid.

Formula: COS

Constants:
  Mol. Wt. 60.07
  M. P. -138°C
  B. P. 49.9°C
  Density (liquid) 1.24 @ -87°C
  Vap. D. 2.1

Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Inhalation 3
  Chronic Local: U
  Chronic Systemic: Inhalation 3

Fire Hazard: Dangerous, when exposed to heat or flame.

Spontaneous Heating: No

To Fight Fire: Carbon dioxide, dry chemical or water spray (Section 6). See also Sulfides.

Explosion Hazard: Moderate, when exposed to heat or flame (Section 7). See also Sulfides.

Explosive Range: 12 - 28.5%

Disaster Control: Highly dangerous; shock can shatter the container and release contents; when heated to decomposition, it emits highly toxic fumes; it can react vigorously with oxidizing materials.

Ventilation Control (use moderate rate):

Section 2
Storage and Handling: Section 7

CARBON PAPER
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: 0
  Chronic Local: Allergen 1
  Chronic Systemic: 0

CARBON REMOVER, LIQUID
Constant:
  Flash P. Less than 80°F
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Inflammable liquid; red label.

CARBON SELENO SULFIDE
Description: Yellow, oily liquid.
Formula: CSeS
Constants:
  Mol. Wt. 123.04
  M. P. −75.2°C
  B. P. 85.6°C
  Density 1.9874
  Vap. Press. 100 mm @28.3°C
Toxicity: See Selenium Compounds and Sulfides.
Fire Hazard: See Selenium Compounds and Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Selenium Compounds and Sulfides.
Storage and Handling: Section 7

CARBON SUBOXIDE
Description: Colorless gas or liquid.
Formula: C_3O_2
Constants:
  Mol. Wt. 68.03
  M. P. −107°C
  B. P. 6.3°C
  Density Liq. 1.114 @0°C
Toxicity: Unknown

CARBON SUBSULFIDE
Description: Red liquid.
Formula: C_3S_2
Constants:
  Mol. Wt. 100.16
  M. P. 0.4°C
  Density 1.274
  Vap. Press. 1 mm @14.0°C
Toxicity: May resemble carbon disulfide. See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

CARBON SULFIDE TELLURIDE
Description: Yellow-red crystals.
Formula: CSTe
Constants:
  Mol. Wt. 171.69
  M. P. −54°C
  B. P. Decomposes > −54.0°C
  Density 2.9 @50°C
Toxicity: May be similar to that of carbon disulfide. See also Tellurium Compounds and Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling; Section 7

CARBON TETRABROMIDE
Synonym: Tetrabromomethane.
Description: Colorless, monoclinic tablets.
Formula: CBr_4
Constants:
  Mol. Wt. 331.67
  M. P. Alpha 48.4°C; Beta 90.1°C
  B. P. 189.5°C
  Density 3.42
  Vap. Press. 40 mm @96.3°C
Toxicity: See Halogenated Hydrocarbons.
Disaster Control: See Halogenated Hydrocarbons.
Storage and Handling: Section 7

CARBON TETRACHLORIDE
Synonym: Tetrachloromethane.
Description: Colorless liquid; heavy, ethereal odor.
Formula: CCl_4
Constants:
  Mol. Wt. 153.84
  M. P. −22.6°C
  B. P. 76.8°C
  Freezing P. −22.9°C
  Flash P. None
  Density 1.597 @20°C
  Vap. Press. 100 mm @23.0°C

Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 1
Chronic Local: Irritant 1
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3

MAC: ACGIH (accepted): 25 parts per million in air; 157 milligrams per cubic meter of air.

Toxicology: Carbon tetrachloride has a narcotic action resembling that of chloroform, though not as strong. Following exposures to high concentrations, the workman may become unconscious, and if exposure is not terminated, death can follow from respiratory failure. In cases of narcosis that recover, the aftereffects are more serious than those of delayed chloroform poisoning, usually taking the form of damage to the kidneys, liver and lungs. Exposure to lower concentrations, insufficient to produce unconsciousness, usually results in severe gastro-intestinal upset, and may progress to serious kidney and hepatic damage. The kidney lesion is an acute nephrosis; the liver involvement consists of an acute degeneration of the central portions of the lobules. Where recovery takes place, there may be no permanent disability. Marked variation in individual susceptibility to carbon tetrachloride exists, some persons appearing to be unaffected by exposures which seriously poison their fellow-workers. Alcoholism and previous liver and kidney damage seem to render the individual more susceptible. Concentrations of the order of 1,000 to 1,500 ppm are sufficient to cause symptoms if exposure continues for several hours. Repeated daily exposure to such concentrations may result in poisoning.

Though the common form of poisoning following industrial exposure is usually one of gastro-intestinal upset, which may be followed by renal damage, other cases have been reported in which the central nervous system has been affected, with production of polyneuritis, narrowing of the visual fields, and other neurological changes. Prolonged exposure to small amounts of carbon tetrachloride has also been reported as causing cirrhosis of the liver.

Locally, a dermatitis may be produced following long or repeated contact with the liquid. The skin oils are removed, and the skin becomes red, cracked and dry (Section 9). The effect of carbon tetrachloride on the eyes either as a vapor or as a liquid, is one of irritation with lacrimation and burning.

Industrial poisoning is usually acute, with malaise, headache, nausea, dizziness, and confusion, which may be followed by stupor and sometimes loss of consciousness. Symptoms of liver and kidney damage may follow later, with development of dark urine, sometimes jaundice and liver enlargement, followed by scanty urine, albumenuria and renal casts , uremia may develop and cause death. Where the exposure has been less acute, the picture is usually one of headache, dizziness, nausea, vomiting, epigastric distress, loss of appetite, and fatigue. Visual distrubances (blind spots, spots before the eyes, a visual "haze" and restriction of the visual fields), secondary anemia, and occasionally a slight jaundice may occur. Dermatitis may be noticed on the exposed parts.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene.

Ventilation Control (use moderate rate): Section 2

Personnel Hygiene: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations: Section 11. MCA warning label.

CARBON TETRAFLUORIDE

Synonym: Tetrafluoromethane.

Description: Colorless gas.

Formula: CF_4

Constants: Mol. Wt. 88.01
M. P. −184°C

B. P. −127.7°C
Density 1.96 @−184°C
Toxicity: See Halogenated Hydrocarbons.
Disaster Control: See Halogenated Hydrocarbons.
Storage and Handling: Section 7

CARBON TETRAIODIDE

Synonym: Tetraiodemethane.
Description: Octahedral, red crystals.
Formula: CI_4
Constants:
Mol. Wt. 519.69
M. P. 171°C Decomposes
Density 4.32
Toxicity: See Halogenated Hydrocarbons.
Disaster Control: See Halogenated Hydrocarbons.
Storage and Handling: Section 7

CARBONYL BROMIDE

Synonym: Carbon oxybromide.
Description: Liquid.
Formula: $COBr_2$
Constants:
Mol. Wt. 187.84
B. P. 64.5°C
Density 2.44
Toxic Hazard:
Acute Local: Irritant 3; Inhalation 3
Acute Systemic: Inhalation 3
Chronic Local: U
Chronic Systemic: U
Fire Hazard: See Carbon Monoxide and Bromine.
Explosion Hazard: See Carbon Monoxide.
Disaster Control: Dangerous; shock can shatter the container and release contents; when heated to decomposition, it emits highly toxic fumes; it will react with water or steam to produce toxic and flammable vapors.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

CARBONYL CHLORIDE. See Carbon Oxychloride.

CARBONYL CYANIDE

Synonym: Carbon oxycyanide.
Description: Colorless liquid.
Formula: $CO(CN)_2$
Constants:
Mol. Wt. 80.05
B. P. 65.5°C
Density 1.124
Toxicity: See Cyanides and Carbon Monoxide.
Fire Hazard: See Hydrogen Cyanide and Carbon Monoxide.
Explosion Hazard: See Hydrogen Cyanide and Carbon Monoxide.
Disaster Control: Cyanides and Carbon Monoxide.
Storage and Handling: Section 7

CARBONYL FLUORIDE

Synonym: Fluoroformyl fluoride.
Description: Colorless gas.
Formula: COF_2
Constants: Mol. Wt. 66.01
M. P. —114°C
B. P. —83°C
Density 1.139 @—114°C
Toxicity: See Fluorides and Carbon Monoxide.
Fire Hazard: See Carbon Monoxide.
Explosion Hazard: See Carbon Monoxide.
Disaster Control: See Fluorides and Carbon Monoxide.
Storage and Handling: Section 7

CARBONYLS

Description: The $(CO)^-$ group with a metal.
Toxic Hazard Rating:
Acute Local: Inhalation 3
Acute Systemic: Inhalation 3
Chronic Local: U
Chronic Systemic: Inhalation 3
Caution: Most carbonyls are highly toxic. See also specific Carbonyl.
Fire Hazard: Moderate, when exposed to heat or flame. More or less readily evolve carbon monoxide. See also Carbon Monoxide and Powdered Metals.
Explosion Hazard: Moderate, when exposed to heat or flame (Section 7).
Explosive Range: See Carbon Monoxide.
Caution: Powerful oxidizers; can react violently with carbonyls. Heat can cause carbonyls to

decompose.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of carbon monoxide; it will react with water or steam to produce toxic and flammable vapors; it can react vigorously with oxidizing materials.
Storage and Handling: Section 7

CARBONYL SULFIDE. See Carbon Oxysulfide.

CARBOPROPOXIDE, STABILIZED

Description: Liquid.
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Moderately dangerous in a disaster because, when heated to decomposition, it emits toxic fumes; it can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Corrosive liquid; white label.

CARBOPROPOXIDE, UNSTABILIZED

Description: Solid.
Toxic Hazard Rating:
  Acute Local: Irritant 3: Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; it can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable solid; yellow label.

"CARBORUNDUM". See Silicon Carbide.

"CARBOWAX" METHOXY POLYETHYLENE GLYCOL 350

Description: Slightly viscous liquid.
Formula: $CH_3OCH_2(CH_2OCH_2)_xCH_2OH$
Constants:
  Mol. Wt. 330 - 370
  M. P. −5° to −10°C
  Flash P. 440°F (O.C.)
  Density 1.09 @ 20°/20°C
  Vap. Press. < 50 mm @ 37°C
Toxicity: See Glycols.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

"CARBOWAX" METHOXY POLYETHYLENE GLYCOL 550

Description: Soft, wax-like solid.
Formula: $CH_3OCH_2(CH_2OCH_2)_xCH_2OH$
Constants:
  Mol. Wt. 525 - 575
  M. P. 25 - 15°C
  Flash P. 460°F (O.C.)
  Density 1.07 @ 55°/20°C
  Vap. Press. < 50 mm @ 37°C
Toxicity: See Glycols.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

CARBOXY METHYL MERCAPTO-SUCCINIC ACID

Description: White powder.
Formula: $C_6H_8O_6S$
Constants:
  Mol. Wt. 208.2
  M. P. 136 - 128°C
Toxicity: Details unknown. Preliminary tests indicate toxicity is somewhat less than citric acid.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

CARBOYS, ACID, EMPTY
Toxicity: See specific material shipped.
Disaster Control: Slightly dangerous; when heated, they may emit toxic fumes.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: See Section 11.
  Coast Guard Classification: Hazardous article.

CARBURIZING SALT. See Cyanides.

CARNAUBA WAX
Synonym: Brazil wax.
Constants:
  Flash P. 540°F (C. C.)
  M. P. 85°C
Toxic Hazard Rating:
  Acute Local: 0
  Acute Systemic: 0
  Chronic Local: Allergen 1
  Chronic Systemic: 0
Fire Hazard: Slight, when exposed to heat; it can react with oxidizing materials.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

CARTRIDGE BAGS, EMPTY, WITH BLACK POWDER IGNITERS
See Explosives, Low.
Shipping Regulations: Section 11.
  I. C. C. Classification: Explosive C
  Coast Guard Classification: Explosive C

CARTRIDGE CASES, EMPTY, PRIMED. See Explosives, Low.
Shipping Regulations: Section 11.
  I. C. C. Classification: Explosive C
  Coast Guard Classification: Explosive C

CASE-HARDENING COMPOUNDS
See Cyanides.

CASHEW NUT SHELL OIL
Composition: Mostly anacardic acid.
Toxic Hazard Rating:
  Acute Local: Irritant 3
  Acute Systemic: U
  Chronic Local: Allergen 3
  Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

CASTOR-BEAN MEAL
Toxicity: This material contains the very toxic materials Ricin and Ricinine. It is also a very potent allergen.

CASTOR OIL
Synonyms: Ricinus oil.
Description: A colorless to pale-yellow viscous liquid, characteristic odor.
Constants:
  M. P. -12°C
  B. P. 313°C
  Flash P. 445°F (C. C.)
  Density 0.96
  Autoign. Temp. 840°F
Toxic Hazard Rating:
  Acute Local: Irritant 1; Allergen 1
  Acute Systemic: Ingestion 2
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat.
Spontaneous Heating: Yes.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

CASTOR OIL PLANT DUST
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; it can react vigorously with oxidizing materials (Section 6).
Explosion Hazard: Slight, when exposed to flame (Section 7).
Personnel Protection: Section 3
Personal Hygiene: Section 3

CATECHOL. See Pyrocatechol.

CATIONIC AMINE 220
Synonym: 1-Hydroxyethyl-1,

2-heptadecenyl glyoxaldene.
Formula: $C_{17}H_{33}CH(CH_2)_2NHC_2CH_2OH$
Constants:
  Mol. Wt. 350.58
  Flash P. 465°F (O.C.)
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

CATTLE FEED DUST
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: 0
  Chronic Local: Allergen 1
  Chronic Systemic: Inhalation 1
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Spontaneous Heating: Yes; dangerous when very dry or very moist.
Explosion Hazard: Slight, when exposed to flame (Section 7).
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3

CAUSTIC ALCOHOL SOLUTION
See Sodium Hydroxide and Ethyl Alcohol.

CAUSTIC POTASH. See Potassium Hydroxide.
Shipping Regulations: Section 11.
  Coast Guard Classification: Hazardous article.
  MCA warning label.

CAUSTIC POTASH, LIQUID. See Potassium Hydroxide.
Shipping Regulations: Section 11.
  I.C.C. Classification: Corrosive liquid; white label.
  Coast Guard Classification: Corrosive liquid; white label.
  MCA warning label.

CAUSTIC SODA. See Sodium Hydroxide.
Shipping Regulations: Section 11.
  Coast Guard Classification: Hazardous article.
  MCA warning label.

CAUSTIC SODA, LIQUID. See Sodium Hydroxide.
Shipping Regulations: Section 11.
  I.C.C. Classification: Corrosive liquid; white label.
  Coast Guard Classification: Corrosive liquid; white label.
  MCA warning label.

CEDAR
Description: A wood.
Toxic Hazard Rating:
  Acute Local: Inhalation 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Toxicology: The wood dust contains chemical irritants which can cause conjunctivitis, intense lachrymation, iridocyclitis, keratitis as well as dermatitis (Section 9).
Treatment and Antidotes: Removal from exposure will cause the symptoms to disappear.
Fire Hazard: Moderate, when exposed to heat.
Explosion Hazard: Slight in the form of dust when exposed to flame. See also Dusts.
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

CEDAR WOOD OIL
Description: Colorless or slightly yellow, viscid liquid.
Composition: Cedrene and cedrol.
Constant:
  Density 0.940-0.950 @ 20°/20°C
Toxic Hazard Rating:
  Acute Local: Irritant 1: Allergen 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

"CELANESE SOLVENT 203"
Description: Liquid; odor of isobutanol.
Constants:
  B. P. 110 - 120°C
  Flash P. 100°F (T.O.C.)
  Density 0.805-0.815 @ 20°/4°C

Toxicity: See Isobutyl Alcohol, n-Butyl Alcohol and Amyl Alcohol.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

"CELANESE SOLVENT 301"
Description: Liquid.
Constants:
B. P. 97 - 100°C
Flash P. 90°F (T.O.C.)
Density 0.804-0.808 @20°/4°C
Toxicity: See n-Propanol, sec-Butanol.
Fire Hazard: Dangerous, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

"CELANESE SOLVENT 601"
Description: Liquid, ether-like odor.
Constants:
B. P. 74 - 84°C
Flash P. 10°F (T.O.C.)
Density 0.840-0.850 @20°/4°C
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

"CELANESE SOLVENT 901"
Description: Liquid.
Constants:
B. P. 125 - 155°C
Flash P. 115°F (T.O.C.)
Density 0.835-0.840 @20°/4°C
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

CELERY SEED
Description: Volatile and fixed oil, bitter extractive and resin.
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

CELLOIDIN. See Nitrocellulose.

"CELLOSOLVE" ACETATE
Synonym: Ethylene glycol monoethyl ether acetate.
Description: Colorless liquid with a mild, pleasant ester-like odor.
Formula: $CH_3COOCH_2CH_2OC_2H_5$
Constants:
Mol. Wt.. 132.17
B. P. 156.4°C
Flash P. 120°F (C.O.C.)
Freezing P. −61.7°C
Density 0.9748 @20°/20°C
Autoign. Temp. 715°F
Vap. Press. 1.2 mm @20°C
Vap. D. 4.72
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: Ingestion 2
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
MAC: ACGIH (accepted); 100 parts per million in air; 540 milligrams per cubic meter of air.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials;
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical, or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, in the form of vapor when exposed to heat (Section 7).
Explosive Range: 1.71% (L.E.L.)
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

"CELLOSOLVE" SOLVENT
Synonym: Ethylene glycol monoethyl ether; 2-ethoxy ethanol.
Description: Colorless liquid; practically odorless.

Formula: $CH_2OHCH_2OC_2H_5$
Constants:
  Mol. Wt. 90.12
  B. P. 135.1°C
  Flash P. 106°F (C.C.)
  Density 0.9360 @15°/15°C
  Autoign. Temp. 460°F
  Vap. Press. 3.8 mm @20°C
  Vap. D. 3.10
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1
  Acute Systemic: Ingestion 2
  Chronic Local: U
  Chronic Systemic: Ingestion 1; Inhalation 1
MAC: ACGIH (accepted); 736 milligrams per cubic meter of air; 200 parts per million of air.
Toxicology: Animal experiments indicate that exposure to air saturated with "Cellosolve" vapor (0.6%) for periods of 18 to 24 hours may produce congestion and edema of the lungs and congestion of the kidneys. Exposure of humans to the same concentration for a few seconds resulted in irritation of the eyes. No cases of poisoning have so far been reported in industry.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, in the form of vapor when exposed to heat or flame (Section 7).
Explosive Range: 2.6 - 15.7%
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

"CELLULOID"

Description: Clear or colored cellulose nitrate.
Constant:
  Density 1.35 - 1.60
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes; it can react with oxidizing materials.
Storage and Handling: Section 7

CELLULOSE DINITRATE

Synonym: Cellulose tetranitrate.
Description: White, amorphous solid.
Formula: $C_{12}H_{16}(ONO_2)_4O_6$
Constants:
  Mol. Wt. 504.3
  Density 1.66
Toxicity: See Nitrocellulose.
Fire Hazard: See Nitrocellulose.
Explosion Hazard: See Nitrocellulose.
Disaster Control: See Nitrocellulose.

CELLULOSE NITRATE. See Nitrocellulose.

CEMENT, LEATHER

Fire Hazard: Dangerous; when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Explosion Hazard: Unknown.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Inflammable liquid; red label.

CEMENT, LIQUID, N.O.S.

Fire Hazard: Dangerous; when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Storage and Handling: Section 7
Shipping Regulation: Section 11.
  I. C. C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Inflammable liquid; red label.

CEMENT, PYROXYLIN

Fire Hazard: Dangerous; when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Storage and Handling: Section 7
Shipping Regulations:
  I. C. C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Inflammable liquid; red label.

CEMENT, ROOFING, LIQUID

Fire Hazard: Dangerous; when

exposed to heat or flame; it can react with oxidizing materials (Section 6).
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

CEMENT, RUBBER

Toxicity: Often contains benzene or other toxic solvents. See specific constituent.
Fire Hazard: Dangerous; when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

CERESIN WAX

Synonym: Earth wax; mineral wax.
Description: White or yellow waxy material.
Constants:
M. P. 68 - 72°C
Density 0.92 - 0.94
Toxic Hazard Ratings:
Acute Local: 0
Acute Systemic: 0
Chronic Local: Allergen 1
Chronic Systemic: U
Personal Hygiene: Section 3

CERIC AMMONIUM NITRATE

Synonym: Cerium-ammonium nitrate.
Description: Small prismatic, orange-red crystals.
Formula:
$Ce(NO_3)_4 \cdot 2NH_4NO_3 + 1\frac{1}{2}H_2O$
Constant:
Mol. Wt. 575.40
Toxicity: See Cerium Compounds and Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

CERIC IODATE

Description: Colorless crystals.
Formula: $Ce(IO_3)_4$
Constant:
Mol. Wt. 839.81
Toxicity: See Cerium Compounds and Iodates.
Fire Hazard: See Iodates.
Disaster Control: See Iodates.
Storage and Handling: Section 7

CERIC NITRATE, BASIC

Description: Long, red needles.
Formula:
$Ce(OH)(NO_3)_3 \cdot 3H_2O$
Constant:
Mol. Wt. 397.21
Toxicity: See Cerium Compounds and Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

CERIUM

Description: Cubic or hexagonal, steel-gray crystals.
Formula: Ce
Constants:
At. Wt. 140.13
M. P. 640°C
B. P. 1400°C
Density Cubic form 6.90; hexagonal form 6.7
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Ingestion 1
Chronic Local: 0
Chronic Systemic: Ingestion 1; Inhalation 1
Toxicology: Cerium resembles aluminum in its pharmacological action as well as in its chemical properties. The insoluble salts such as the oxalate are stated to be nontoxic even in large doses. It is used to prevent vomiting in pregnancy. The average dose is from 0.05 to 0.5 g. Cerium tartrate has been found to produce a direct injurious action on the hearts of small animals. The effect on the nervous system of the rare-earth metals following inhalation may preclude welding operations with these materials to any large extent. Cerium is stated to produce polycythemia but is useless in the treatment of anemia owing to its toxic effects. The salts of cerium increase the blood coagulation rate.
Radiation Hazard: (Section 5).
Artificial isotope Ce^{141}; half-life 29 days; emits beta particles of

0.41 mev (70%); 0.56 mev (30%) and many gamma rays between 0.14-0.32 mev. Hazard Rating, Class II (National Bureau of Standards Handbook No. 42).

Artificial isotope Ce^{144}, half-life: 283 days; emits beta particles of 0.33 mev. The permissible levels are: In body: 5 microcuries. In air: 7×10^{-9} microcurie per milliliter. In water: 4×10^{-2} microcurie per milliliter. Ce^{144} exists in equilibrium with its daughter, Pr^{144}. The permissible levels are given for the equilibrium mixture. Hazard Rating, Class III (National Bureau of Standards Handbook No. 42).

Fire Hazard: Moderate, ignites spontaneously in air at 150-180°C. A strong reducing agent. See also Powdered Metals.
Explosion Hazard: Moderate, in the form of dust when exposed to flame. See also Powdered Metals.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

CERIUM CARBIDE
Description: Hexagonal, red crystals.
Formula: CeC_2
Constant:
Mol. Wt. 164.15
Density 5.23
Toxicity: See Cerium.
Fire Hazard: See Acetylene.
Explosion Hazard: See Acetylene.
Disaster Control: Moderately dangerous; on contact with water, steam, acid or acid fumes, it will react to produce flammable vapors of acetylene.
Storage and Handling: Section 7

CERIUM CHLORIDE
Synonym: Cerous chloride.
Description: Colorless, deliquescent crystals.
Formula: $CeCl_3$
Constants:
Mol. Wt. 246.50
M. P. 848°C
B. P. Decomposes
Density 3.92
Toxicity: See Cerium.

CERIUM COMPOUNDS
Toxicity: The toxicity of cerium compounds may be taken to be that of cerium, except when the anion has a toxicity of its own.

CERIUM TARTRATE
Description: White powder.
Formula: $Ce_2(C_4H_4O_6)_3$
Constant:
Mol. Wt. 724.5
Toxicity: See Cerium

CERIUM TETRABORIDE
Description: Tetragonal crystals.
Formula: CeB_4
Constants:
Mol. Wt. 183.41
Density 5.74
Toxicity: See Cerium and Boron Compounds.
Fire Hazard: See Boron Hydrides.
Explosion Hazard: See Boron Hydrides.

CEROUS AMMONIUM NITRATE
Description: Monoclinic, white, transparent crystals.
Formula:
$2NH_4NO_3 \cdot Ce(NO_3)_3 \cdot 4H_2O$
Constants:
Mol. Wt. 558.32
M. P. 74°C
Toxicity: See Cerium and Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

CEROUS BROMATE
Description: Hexagonal, reddish-white crystals.
Formula: $Ce(BrO_3)_3 \cdot 9H_2O$
Constants:
Mol. Wt. 686.02
M. P. 49°C
Toxicity: See Cerium and Bromates.
Fire Hazard: See Bromates.
Disaster Control: See Bromates.
Storage and Handling: Section 7

CEROUS CYANOPLATINITE
Description: Monoclinic, yellow-blue, lustrous crystals.
Formula: $Ce_2[Pt(CN)_4]_3 \cdot 18H_2O$
Constants:
Mol. Wt. 1502.45
Density 2.657
Toxicity: See Cyanides and Cerium.

Disaster Control: See Cyanides.
Storage and Handling: Section 7

CEROUS FLUORIDE

Description: Hexagonal, white crystals.
Formula: CeF_3
Constants:
  Mol. Wt. 197.13
  M. P. 1324°C
  Density 6.16
Toxicity: See Fluorides and Cerium.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

CEROUS HYDRIDE

Description: Amorphous, dark blue powder.
Formula: CeH_3
Constants:
  Mol. Wt. 143.15
  M. P. Ignites
Toxicity: See Cerium and Hydrides.
Fire Hazard: See Hydrides.
Explosion Hazard: See Hydrides.
Disaster Control: Moderately dangerous; when heated, it emits fumes; on contact with water, steam, acid or acid fumes, it will react to produce hydrogen; it can react vigorously on contact with oxidizing materials.
Storage and Handling: Section 7

CEROUS IODIDE

Description: Reddish-white crystals.
Formula: $CeI_3 \cdot 9H_2O$
Constant:
  Mol. Wt. 683.03
Toxicity: See Cerium and Iodides.

CEROUS NITRATE

Description: Colorless or reddish deliquescent crystals.
Formula: $CE(NO_3)_3 \cdot 6H_2O$
Constants:
  Mol. Wt. 434.25
  M. P. $-3H_2O$ @150°C
  B. P. Decomposes 200°C
Toxicity: See Cerium and Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

CEROUS OXYCHLORIDE

Description: Purple, leaf-like crystals.
Formula: $CeOCl$
Constant:
  Mol. Wt. 191.6
Toxicity: See Cerium and Hydrochloric Acid.
Disaster Control: See Hydrochloric Acid and Phosgene.
Storage and Handling: Section 7

CEROUS SELENATE

Description: Rhombic crystals.
Formula: $Ce_2(SeO_4)_3$
Constants:
  Mol. Wt. 709.14
  Density 4.456
Toxicity: See Selenium and Cerium.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

CEROUS SULFIDE

Description: Red crystals; brown, dark purple powder.
Formula: Ce_2S_3
Constants:
  Mol. Wt. 376.46
  M. P. Decomposes
  Density 5.020 @11°C
Toxicity: See Sulfides and Cerium.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

CESIUM

Description: Hexagonal crystals; silver-white, ductile metal.
Formula: Cs
Constants:
  At. Wt. 132.91
  M. P. 28.5°C
  B. P. 670°C
  Density 1.873
  Vap. Press. 1 mm @279°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 1
  Chronic Local: U
  Chronic Systemic: Ingestion 1
Toxicology: Cesium is quite similar to potassium in its elemental state. It has been shown, however, to have pronounced physiological action in experiments with animals. Hyperirritability, including marked spasms, has been shown to follow the administration of cesium in amounts equivalent to the potassium content of the diet.

It has been found that, by replacing the potassium in the diet of rats with cesium, death occurred after 10 days to 17 days.

Radiation Hazard (Section 5): Artificial isotope Ce^{134}, half-life: 2.3 years; emits beta particles of 0.67 mev (75%), 0.09 mev (25%) and gamma rays of 0.60 mev. Artificial isotope Cs^{137}, half-life: 35 years; emits beta particles of 0.52 mev (95%), 1.2 mev (5%) and gamma rays of 0.67 mev. The permissible levels are: In body: 90 microcuries. In air: 2×10^{-7} microcurie per milliliter. In water: 1.5×10^{-3} microcurie per milliliter. Cs^{137} exists in equilibrium with its daughter, the radioactive form of Ba^{137} The permissible levels are given for the equilibrium mixture. Hazard Rating Class II (National Bureau of Standards Handbook No. 42).

Fire Hazard: Dangerous, by chemical reaction; reacts with oxidizing materials. Can ignite spontaneously in moist air. See also Sodium.

Explosion Hazard: Moderate, by chemical reaction. Reacts with moisture to liberate hydrogen (Section 7).

Disaster Control: Moderately dangerous; it will react with water or steam to produce heat and hydrogen; on contact with oxidizing materials, it can react vigorously.

Personal Hygiene: Section 3

Storage and Handling: Section 7

CESIUM BROMATE

Description: Solid.

Formula: $CsBrO_3$

Constant:
Mol. Wt. 260.83

Toxicity: See Bromates and Cesium.

Fire Hazard: See Bromates.

Disaster Control: See Bromates.

Storage and Handling: Section 7

CESIUM BROMOCHLOROIODIDE

Description: Rhombic, yellow-red crystals.

Formula: CsBrClI

Constants:
Mol. Wt. 375.20
M. P. 235°C
B. P. Decomposes 290°C

Toxicity: See Bromides, Iodides and Cesium.

CESIUM BROMODIIODIDE

Formula: CsI_2Br

Constants:
Mol. Wt. 466.67
M. P. 195.5°C

Toxicity: See Bromides, Iodides and Cesium.

CESIUM CHLORATE

Description: White crystals.

Formula: $CsClO_3$

Constants:
Mol. Wt. 216.37
Density 3.57

Toxicity: See Chlorates and Cesium.

Fire Hazard: See Chlorates.

Disaster Control: See Chlorates.

Storage and Handling: Section 7

CESIUM CHLOROAURATE

Description: Monoclinic, yellow crystals.

Formula: $CsAuCl_4$

Constant:
Mol. Wt. 471.94

Toxicity: See Gold Compounds and Cesium.

CESIUM CHLORODIBROMIDE

Description: Yellow crystals.

Formula: $CsBr_2Cl$

Constants:
Mol. Wt. 328.20
M. P. 191°C

Toxicity: See Bromides and Cesium.

Disaster Control: See Bromides.

Storage and Handling: Section 7

CESIUM CHLOROPLATINATE

Description: Cubic, yellow crystals.

Formula: Cs_2PtCl_6

Constants:
Mol. Wt. 673.79
M. P. Decomposes

Toxicity: See Platinum Compounds and Cesium.

Storage and Handling: Section 7

CESIUM CHLOROSTANNATE

Description: Cubic, white crystals.

Formula: Cs_2SnCl_6

Constants:
Mol. Wt. 597.26
Density 3.33
Toxicity: See Tin Compounds.
Disaster Control: See Chlorides.
Storage and Handling: Section 7

CESIUM CHROMATE
Description: Alpha: yellow prisms; beta: yellow, rhombic crystals.
Formula: Cs_2CrO_4
Constants:
Mol. Wt. 381.83
Density 4.237
Toxicity: See Chromium Compounds.
Storage and Handling: Section 7

CESIUM COMPOUNDS
Toxicity: Probably have the toxicity of cesium unless they contain a more toxic radical. Toxicity is of minor importance in industry. See also Cesium.
Personal Hygiene: Section 3

CESIUM CYANIDE
Description: Colorless crystals.
Formula: CsCN
Constant:
Mol. Wt. 158.93
Toxicity: See Cyanides.
Fire Hazard: See Cyanides.
Explosion Hazard: See Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

CESIUM DIBROMOIODIDE
Description: Rhombic crystals.
Formula: $CsIBr_2$
Constants:
Mol. Wt. 419.66
M. P. 248°C
B. P. Decomposes 320°C
Toxicity: See Bromides, Iodides and Cesium.
Disaster Control: See Bromides and Iodides.
Storage and Handling: Section 7

CESIUM DICHLOROBROMIDE
Description: Crystals.
Formula: $CsBrCl_2$
Constants:
Mol. Wt. 283.74
M. P. 205°C
Toxicity: See Bromides and Cesium.
Disaster Control: See Bromides.
Storage and Handling: Section 7

CESIUM DICHLOROIODIDE
Description: Rhombic, pale orange crystals.
Formula: $CsICl_2$
Constants:
Mol. Wt. 330.74
M. P. 230°C
B. P. Decomposes 290°C
Density 3.86
Toxicity: See Iodides and Cesium.

CESIUM DISULFIDE
Description: Amorphous or dark-red crystals.
Formula: Cs_2S_2
Constants:
Mol. Wt. 329.95
B. P. > 800°C
M. P. 460°C
Toxicity: See Sulfides and Cesium.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

CESIUM FLUOGERMANATE
Description: Isotropic crystals; regular; octahedral.
Formula: Cs_2GeF_6
Constants:
Mol. Wt. 452.42
Density 4.10
Toxicity: See Fluogermanates.
Disaster Control: See Fluogermanates.
Storage and Handling: Section 7

CESIUM FLUORIDE
Description: Cubic, colorless crystals.
Formula: CsF
Constants:
Mol. Wt. 151.91
M. P. 683°C
B. P. 1251°C
Density 3.586
Vap. Press. 1 mm @ 712°C
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

CESIUM FLUOSILICATE
Description: Cubic, white crystals.
Formula: Cs_2SiF_6
Constants:
Mol. Wt. 407.88
Density 3.372 @17°C
Toxicity: See Fluosilicates.
Disaster Control: See Fluosilicates.
Storage and Handling: Section 7

CESIUM FLUOTELLURITE
Description: Colorless needles.
Formula: $CsTeF_5$
Constant: Mol. Wt. 355.52
Toxicity: See Tellurium Compounds, and Fluorides.
Disaster Control: See Tellurium Compounds and Fluorides
Storage and Handling: Section 7

CESIUM GALLIUM SELENATE
Description: Colorless crystals.
Formula: $CsGa(SeO_4)_2 \cdot 12H_2O$
Constant: Mol. Wt. 704.74
Toxicity: See Selenium Compounds and Gallium Compounds.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

CESIUM GALLIUM SULFATE
Description: Cubic, colorless crystals.
Formula: $CsGa(SO_4)_2 \cdot 12H_2O$
Constants:
Mol. Wt. 610.95
Density 2.113
Toxicity: See Cesium and Gallium Compounds.

CESIUM HEXASULFIDE
Description: Bright, red crystals.
Formula: Cs_2S_6
Constants:
Mol. Wt. 458.22
M. P. 186°C
Toxicity: See Sulfides and Cesium.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

CESIUM HYDRIDE
Description: White crystals.
Formula: CsH
Constants:
Mol. Wt. 133.92
M. P. Decomposes
Density 2.7
Toxicity: See Cesium and Hydrides.
Fire Hazard: See Hydrides.
Explosion Hazard: See Hydrides.
Disaster Control: Moderately dangerous; when heated or on contact with water or steam, it will react to produce heat and hydrogen; it can react with oxidizing materials.
Storage and Handling: Section 7

CESIUM HYDROXIDE
Description: Colorless, yellowish, very deliquescent crystals.
Formula: CsOH
Constants:
Mol. Wt. 149.92
M. P. 272.3°C
Density 3.675
Toxicity: See Cesium

CESIUM IODATE
Description: Monoclinic, white crystals.
Formula: $CsIO_3$
Constants:
Mol. Wt. 307.83
Density 4.85
Toxicity: See Iodates and Cesium.
Fire Hazard: See Iodates.
Disaster Control: See Iodates.
Storage and Handling: Section 7

CESIUM MERCURIC BROMIDE
Description: Rhombic crystals.
Formula: $CsBr \cdot 2HgBr_2$
Constant:
Mol. Wt. 933.71
Toxicity: See Mercury Compounds, Inorganic, Bromides and Cesium.
Disaster Control: See Mercury Compounds, Inorganic, and Bromides.
Storage and Handling: Section 7

CESIUM MERCURIC CHLORIDE
Description: Cubic or rhombic, colorless crystals.
Formula: $CsCl \cdot HgCl_2$
Constant:
Mol. Wt. 439.89
Toxicity: See Mercury Compounds, Inorganic.
Disaster Control: See Mercury Compounds, Inorganic.
Storage and Handling: Section 7

CESIUM METAPERIODATE
Description: Rhombic, white plates.

Formula: $CsIO_4$
Constants:
Mol. Wt. 323.83
Density 4.259
Toxicity: See Iodates and Cesium.
Fire Hazard: See Iodates.
Disaster Control: See Iodates.
Storage and Handling: Section 7

CESIUM MONOBROMIDE

Description: Cubic, colorless crystals.
Formula: CsBr
Constants:
Mol. Wt. 212.83
M. P. 636°C
B. P. 1300°C
Density 4.44; liq. 3.04 @700°C
Toxicity: See Bromides and Cesium.

CESIUM MONOIODIDE

Description: Cubic, colorless crystals.
Formula: CsI
Constants:
Mol. Wt. 259.83
M. P. 621°C
B. P. 1280°C
Density 4.510
Toxicity: See Iodides and Cesium.

CESIUM NITRATE

Description: Colorless, hexagonal or cubic, glittering crystalline powder.
Formula: $CsNO_3$
Constants:
Mol. Wt. 194.92
M. P. 414°C
B. P. Decomposes
Density 3.685; 2.71 @500°C
Toxicity: See Cesium and Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

CESIUM NITRITE

Description: Yellow crystals.
Formula: $CsNO_2$
Constant:
Mol. Wt. 178.92
Toxicity: See Nitrites.
Fire Hazard: See Nitrites.
Disaster Control: See Nitrites.
Storage and Handling: Section 7

CESIUM OXALATE

Description: White solid.
Formula: $Cs_2C_2O_4$
Constant:
Mol. Wt. 353.84
Toxicity: See Oxalates.

CESIUM PENTASULFIDE

Description: Solid.
Formula: Cs_2S_5
Constants:
Mol. Wt. 426.15
M. P. 210°C
Density 2.806 @15°C
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

CESIUM PERCHLORATE

Description: Rhombic, colorless crystals.
Formula: $CsClO_4$
Constants:
Mol. Wt. 232.37
M. P. Decomposes
Density 3.327
Toxicity: See Perchlorates and Cesium.
Fire Hazard: See Perchlorates.
Explosion Hazard: See Perchlorates.
Disaster Control: See Perchlorates.
Storage and Handling: Section 7

CESIUM PERMANGANATE

Description: A violet solid.
Formula: $CsMnO_4$
Constants:
Mol. Wt. 251.84
M. P. Decomposes
Density 3.597
Toxicity: See Manganese Compounds.
Fire Hazard: See Permanganates.
Disaster Control: See Permanganates.
Storage and Handling: Section 7

CESIUM SULFIDE

Description: White, deliquescent crystals.
Formula: $Cs_2S \cdot 4H_2O$
Constant:
Mol. Wt. 369.95
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

CESIUM TETRASULFIDE

Description: Yellow crystals.
Formula: Cs_2S_4
Constants:
  Mol. Wt. 394.08
  M. P. 160°C Decomposes
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

CESIUM TRIBROMIDE

Description: Rhombic crystals.
Formula: $CsBr_3$
Constants:
  Mol. Wt. 372.66
  M. P. 180°C
Toxicity: See Bromides and Cesium.
Disaster Control: See Bromides.
Storage and Handling: Section 7

CESIUM TRISULFIDE

Description: Yellow leaf.
Formula: Cs_2S_3
Constants:
  Mol. Wt. 362.02
  M. P. 217°C
  B. P. 780°C
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

CETYL ALCOHOL

Synonym: Hexadecanol.
Description: Solid or leaf-like crystals.
Formula: $C_{16}H_{33}OH$
Constants:
  Mol. Wt. 242.4
  M. P. 49.3°C
  B. P. 344°C
  Density 0.8176 @50°/4°C
Toxicity: Practically non-toxic.
Fire Hazard: Moderate, when exposed to heat and/or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

CETYL BROMIDE

Description: Dark yellow liquid.
Formula: $CH_3(CH_2)_{15}Br$
Constants:
  Mol. Wt. 305.3
  B. P. 186 - 197°C @10 mm
  Freezing P. 15°C
  Flash P. 350°C
  Density 0.991 @25°/25°C
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; it can react with oxidizing materials.
Storage and Handling: Section 7

CETYL ISOQUINOLINIUM BROMIDE

Toxicity: Details unknown; a fungicide.
Fire Hazard: Slight; on decomposition it emits toxic fumes.
Storage and Handling: Section 7

CHAMOMILE OIL

Description: Blue liquid, turning brownish-yellow.
Composition: Amyl and butyl esters of angelic and tiglic acids, butyric acid, etc.
Constant:
  Density 0.905-0.915 @15°/15°C
Toxic Hazard Rating:
  Acute Local: 0
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

CHARCOAL

Synonym: Carbon
Description: Black amorphous solid.
Composition: C + impurities.
Constants:
  Mol. Wt. 12.0
  M. P. > 6300°F
  B. P. 4200°C
  Density 3.51
Toxic Hazard Rating:
  Acute Local: 0
  Acute Systemic: 0
  Chronic Local: Inhalation 1
  Chronic Systemic: 0
Caution: Carbon itself has no toxic action, but if it contains impurities,

these may be toxic.
Fire Hazard: Moderate; reacts with oxidizing materials.
Spontaneous Heating: Yes, particularly when wet, freshly calcined or tightly packed.
To Fight Fire: Water (Section 6).
Explosion Hazard: Slight, when exposed to heat or flame.
Ventilation Control (use optional): Section 2
Storage and Handling: Section 7

CHARCOAL, ACTIVATED
Synonym: Activated carbon.
Description: Black amorphous solid.
Composition: C + impurities
Constants:
  Mol. Wt. 12.0
  M. P. > 6300°F
  B. P. 7600°F
  Density 3.51
Toxicity: See Charcoal.
Fire Hazard: See Charcoal.
Explosion Hazard: See Charcoal.
Disaster Control: See Charcoal.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid; yellow label.

CHARCOAL BRIQUETTES. See Charcoal.
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable solid.
  Coast Guard Classification: Inflammable solid.

CHARCOAL, SHELL. See Charcoal.
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid.

CHARCOAL, WET. See also Charcoal.
Shipping Regulations: Section 11.
  Coast Guard Classification: Not permitted.

CHARCOAL, WOOD (GROUND, CRUSHED, GRANULATED OR PULVERIZED). See also Charcoal.
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid; yellow label.

CHARCOAL, WOOD (LUMP). See also Charcoal.
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid.

CHARCOAL, WOOD SCREENINGS, MADE FROM "PINON". See also Charcoal.
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid.

CHARCOAL, WOOD SCREENINGS OTHER THAN "PINON". See also Charcoal.
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable solid; yellow label not accepted.
  Coast Guard Classification: Inflammable solid; yellow label.

CHARCOAL WOOD SCREENINGS, WET. See also Charcoal.
Shipping Regulations: Section 11.
  Coast Guard Classification: Not permitted.

CHELIDONINE
Description: White crystalline powder.
Formula: $C_{20}H_{19}O_5N \cdot H_2O$
Constants:
  Mol. Wt. 371.38
  M. P. 135 - 136°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: U
Toxicology: A central nervous system depressant, causing sleepiness, depression, slowing of pulse, and in large doses, coma and circulatory failures.
Treatment and Antidotes: Stimulants, epinephrine, pilocarpine. Call a physician.

Fire Hazard: Slight; on decomposition it emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

CHELIDONINE HYDROCHLORIDE
See Chelidonine.

CHELIDONINE PHOSPHATE. See Chelidonine.

CHELIDONINE TANNATE. See Chelidonine.

"CHEM-D". See DDT.

CHEMICAL AMMUNITION (CONTAINING CLASS A POISONS, LIQUIDS OR GASES)
Toxicity: All Class A poisons are highly toxic. See individual components.
Shipping Regulations: Section 11.
I. C. C. Classification: Poison A; not accepted.
Coast Guard Classification: Poison A; poison gas label.

CHEMICAL AMMUNITION (CONTAINING CLASS B POISONS, LIQUIDS OR GASES)
Toxicity: All Class B poisons are toxic. See individual components.
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

CHEMICAL AMMUNITION (CONTAINING CLASS C POISONS, LIQUIDS OR SOLIDS)
Toxicity: All Class C poisons are moderately toxic. See individual components.
Shipping Regulations: Section 11.
I. C. C. Classification: Poison C; tear gas label.
Coast Guard Classification: Poison C; tear gas label.

CHEMICAL AMMUNITION, EXPLOSIVE. See Explosives.

CHEMICAL KITS
Shipping Regulations: Section 11.
Coast Guard Classification: Corrosive liquid.

CHINESE WAX
Description: White to yellowish-white solid.
Composition: Excretion of an insect. Primarily ceryl cerotate.
Constants:
M. P. 92°C
Density 0.93
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

CHLORAL
Synonym: Trichloracetaldehyde.
Description: Oily liquid; irritating odor.
Formula: C_2HCl_3O
Constants:
Mol. Wt. 147.4
M. P. −57.5°C
B. P. 97.8°C
Flash P. None
Density 1.510 @20°/4°C
Vap. D. 5.1
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: Ingestion 3
Chronic Local: U
Chronic Systemic: Ingestion 2
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Ventilation Control (use normal rate).
MCA warning label.

CHLORAL HYDRATE
Synonyms: Trichloroacetic aldehyde, hydrated.
Description: Transparent, colorless crystals; aromatic, penetrating, slightly acrid odor and slightly bitter, caustic taste.
Formula: $CCl_3CH(OH)_2$

Constants:
Mol. Wt. 165.41
M. P. 52°C
B. P. 97.5°C
Density 1.901
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 3
Chronic Local: U
Chronic Systemic: Ingestion 2
Toxicology: Chloral hydrate is a poisonous drug popularly called "knockout drops". The liquid and vapors are both very dangerous to the eyes. If this material is ingested, the pupils contract during sleep, but dilate upon waking. A number of incidents have been reported where it was given in alcoholic beverages and death was caused when only its hypnotic effect was desired. Recently there has been much addiction to chloral hydrate. These addicts are mostly between the ages of 21 and 40 years. In the majority of cases they are also addicted to alcohol or opium. Occasionally this material may produce excitement and delirium. Nausea and vomiting may be the result of local action of the drug upon the stomach. The respiration is irregular and shallow and the pulse is scarcely perceptible. The pupils are moderately contracted, but rarely dilated. The face is cyanotic or in the early stages, flushed. On account of the dilation of the vessels, the extremities are cold and the blood pressure and temperature are slightly lower, but little more so than in natural sleep. If the dose exceeds 2 to 3 grams, the patient passes into stupor and coma with complete muscular relaxation. The action is very similar to that of chloroform. Death is ordinarily caused by paralysis of the respiratory center. The average fatal dose is placed at about 10 grams. Use caution in giving over the therapeutic dose.
Treatment and Antidotes: A physician should be called at once. Wash out the stomach. Administer strychnine hypodermically. Also give caffein and caffeine with sodium benzoate. Maintain the temperature of the patient with the use of electric pads, hot water bottles and blankets if necessary.
Fire Hazard: Slight; when heated, it emits toxic fumes.
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

CHLORAMINE-T
Synonyms: Chloramine; sodium p-toluene sulfon chloramide.
Description: White or faintly yellow crystal.
Formula: $C_7H_7ClNNaO_2S \cdot 3H_2O$
Constant: Mol. Wt. 281
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Disaster Control: Moderately dangerous; when heated to decomposition or on contact with acid or acid fumes, it can emit toxic fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

cis-CHLORAQUOTETRAMMINECOBALT (III) CHLORIDE
Description: Rhombic violet crystals.
Formula: $[Co(NH_3)_4(H_2O)Cl]Cl_2$
Constants:
Mol. Wt. 251.40
M. P. Decomposes
Density 1.847
Toxicity: See Cobalt Compounds.

CHLORATE AND BORATE MIXTURES. See also Chlorates, N.O.S. and Boron Compounds.
Shipping Regulations: Section 11.
I.C.C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

CHLORATE OF POTASH. See Potassium Chlorate
Shipping Regulations: Section 11.
I.C.C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

CHLORATE OF SODA. See Sodium Chlorate.
Shipping Regulations: Section 11.
I.C.C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

CHLORATES, N.O.S.
Description: Chlorates are a combination of a metal or hydrogen and the $^-ClO_3$ mono-valent radical. They are crystalline and somewhat deliquescent.
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: Ingestion 2
Chronic Local: Irritant 1
Chronic Systemic: Ingestion 2
Toxicology: The principal toxic effects of chlorates are the production of methemoglobin in the blood and destruction of red blood corpuscles. The latter may lead to irritation of the kidneys. Damage to heart muscle has been reported.
Fire Hazard: Moderate, in contact with flammable matter. When contaminated with oxidizable materials, they are particularly sensitive to friction, heat and shock; powerful oxidizing agents (Section 6).
Explosion Hazard: Moderate, when shocked, exposed to heat or rubbed, particularly when contaminated with sugar, charcoal, shellac, sulfur, starch, sawdust, sulfuric acid, ammonium compounds, cyanides, phosphorus or antimony sulfide.

Chlorates when mixed with combustible materials may form explosive mixtures. For instance, potassium chlorate, when mixed with sulfur or with other combustible substances explodes on friction. Pure chlorates or material which have been spilled on the floor, or mixed with small amounts of impurities, become very sensitive to shock and friction. Water is considered the best agent for fighting fires involving chlorates. In the explosive industry, chlorates are used as oxidizing agents in the primer caps in combination with mercury fulminates, phosphorus, antimony sulfide and other combustible substances. It is used in pyrotechnic mixtures, as a component of airplane flares and aerial bombs. It is also used as a component of permissible explosives. Chlorates are used extensively in the manufacture of chlorate explosives. The chief constituent of such an explosive is from 60 to 80 percent chlorate. This can be the chlorate of ammonium, sodium or potassium. The other ingredients in such a mixture are combustible materials, such as metallic powders, powdered sulfur, powdered charcoal or possibly mixtures of organic matter. Nitro derivatives of benzene, toluene, and other aromatic compounds are also added. Paraffin may be added as a desensitizer. Recently, similar mixtures were used in Europe but with the addition of small amounts of nitroglycerin or collodion cotton. Chlorate explosives are more sensitive than modern permissible explosives, and therefore not as safe as for instance the perchlorate explosives, or the permissibles. Plastic mistures of chlorate explosives (containing nitroglycerin) are somewhat less sensitive to shock and friction, in spite of the nitroglycerin present, than the dryer explosives with no nitroglycerin. In this case the nitroglycerin or "explosive oil," as it is known, serves to wet the rest of the mixture. Barium chlorate is shipped and stored in wooden boxes, barrels, or kegs. It should have isolated storage in a cool, ventilated place, away from acute fire hazards and should not be stored in the same building with combustible materials, acids, sulfur, powdered magnesium or powdered aluminum. Examples of chlorates used in the explosive industry, would be potassium chlorate, sodium chlorate and barium chlorate.
Disaster Control: Moderate; shock will explode them; when heated to decomposition, they can emit toxic fumes and explode; can react

with reducing materials.
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Oxidizing material; yellow label.

CHLORATES, N.O.S. WET. See also Chlorates, N.O.S.
Shipping Regulations: Section 11.
I.C.C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

CHLORDANE

Synonyms: 1,2,4,5,6,7,8,8 Octachloro-4,7 -methano -3a,4,7,7a-tetra hydroindane.
Description: Colorless to amber, odorless, viscous liquid.
Formula: $C_{10}H_6Cl_8$
Constants: Mol. Wt. 409.75
B. P. 175°C
Density 1.57 - 1.67 @60°/60°F
Toxicity: Probably toxic; an insecticide.
MAC: AGGIH (tentative); 2.0 milligrams per cubic meter of air.
Toxicology: Chlordane is readily absorbed through the skin as well as through other portals. It is a central nervous system stimulant whose exact mode of action is unknown. Animals poisoned by this and related compounds show an extremely marked loss of appetite and neurological symptoms. The fatal dose to man is unknown. It has been estimated to be between 6 and 60 grams ($^1/_5$ to 2 oz.). One person receiving an accidental skin application of 25 percent solution (amounting to something over 30 g. of technical chlordane) developed symptoms within about 40 minutes and died before medical attention was obtained. In two patients, death followed exposure to low oral doses of chlordane (2-4 g.); on microscopic examination both patients showed severe chronic fatty degeneration of the liver, characteristic of chronic alcoholism. Although these two fatalities cannot be attributed exclusively to chlordane, they are entirely consistent with previous observations that the toxicity of other chlorinated hydrocarbons is much enhanced in the presence of chronic liver damage. The dangerous chronic dose in man is unknown.

One person poisoned by chlordane developed convulsions within 40 minutes of gross skin contamination and died, apparently of respiratory failure, before medical aid could be obtained.

Acutely poisoned experimental animals show similar signs. Experimental animals exposed to repeated small doses exhibit hyperexcitability, tremors, and convulsions, and those which survive long enough show marked anorexia and loss of weight. Symptoms in animals frequently occur within an hour of the administration of a large does, but death often is delayed for several days depending on the dosage and route of administration. In any event, symptoms are of longer duration with chlordane than with DDT under similar conditions.

Laboratory findings are essentially normal, except that the insecticide may be demonstrated in tissues of poisoned animals by means of bioassay. A method for specific, quantitative chemical analysis for chlordane is now available using small amounts of subcutaneous fat. Chronically poisoned animals show degenerative changes in the liver and kidney tubules.
Treatment of Poisoning: Removal of the poison from the skin or the alimentary tract should be attempted. Oil laxatives should be avoided. The nervous symptoms may best be combatted with pentobarbital or phenobarbital.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
MCA warning label.

CHLORETHYL BENZENE

Description: Liquid
Formula: $C_6H_5ClC_2H_5$
Constant: Mol. Wt. 141.6

Toxicity: See Chlorinated Hydrocarbons, Aromatic.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; reacts with oxidizing materials.
Storage and Handling: Section 7

CHLORGUANIDE
Synonyms: 1-(p-chlorophenyl)-5-isopropyl-biguanide hydrochloride.
Description: White powder.
Formula: $ClC_6H_4C_3H_7C_2H_5N_3HCl$
Constant:
  Mol. Wt. 290.2
Toxicity: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

CHLORIC ACID
Description: Colorless solution.
Formula: $HClO_3 \cdot 7H_2O$
Constants:
  Mol. Wt. 210.58
  M. P. < -20°C
  B. P. Decomposes 40°C
  Density 1.282 @14.2°C
Toxic Hazard Rating: (See also Chlorates)
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Dangerous; ignites organic matter upon contact; a very powerful oxidizing agent.
Explosion Hazard: Slight.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; reacts vigorously with reducing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

CHLORIC ETHER
Description: A liquid solution of 60 cc chloroform and 940 cc alcohol.
Toxic Hazard Rating: (See also Ethyl Alcohol and Chloroform)
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 2
  Chronic Local: Irritant 2; Ingestion 2; Inhalation 2
  Chronic Systemic: Ingestion 1; Inhalation 1; Skin Absorption 1
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

CHLORIDE OF LIME. See Calcium Hypochlorite.

CHLORIDES
Toxicity: Varies widely. Sodium chloride (table salt) has very low toxicity, while carbonyl chloride (phosgene) is lethal in small doses.
Disaster Control: May be dangerous; when heated to decomposition, they may emit toxic fumes.
Storage and Handling: Section 7

CHLORINATED BIPHENOLS. See Chlorinated Diphenyls.

CHLORINATED CAMPHENE. See "Toxaphene."

CHLORINATED DIPHENYL OXIDE
Toxic Hazard Rating:
  Acute Local: Irritant 2
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: Irritant 3
  Chronic Systemic: Inhalation 3; Skin Absorption 2
MAC: ACGIH (tentative); 0.5 milligrams per cubic meter of air.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

CHLORINATED DIPHENYLS

Description: Colorless mobile liquid.
Constants:
B. P. 340 - 375°C
Flash P. 383°F (C.O.C.)
Density 1.44 @30°C
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Irritant 3
Chronic Systemic: Inhalation 3; Skin Absorption 2
MAC: ACGIH (accepted): 1 milligram per cubic meter of air.

Toxicology: Like the chlorinated naphthalenes, the chlorinated diphenyls have two distinct actions on the body, namely, a skin effect and a toxic action on the liver. The lesion produced in the liver is an acute yellow atrophy. This hepato-toxic action of the chlorinated diphenyls appears to be increased if there is exposure to carbon tetrachloride at the same time. The higher the chlorine content of the diphenyl compound, the more toxic is it liable to be. Oxides of chlorinated diphenyls are more toxic than the unoxidized materials.

The skin lesion is known as chloracne, and consists of small pimples and dark pigmentation of the exposed areas, initially. Later, comedones and pustules develop. In persons who have suffered systemic intoxication the usual signs and symptoms are nausea, vomiting, loss of weight, jaundice, edema and abdominal pain. Where the liver damage has been severe, the patient may pass into coma and die.

Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, they emit highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11
MCA warning label.

CHLORINATED HYDROCARBONS, ALIPHATIC

Toxicology: The substitution of a chlorine (or other halogen) atom for a hydrogen greatly increases the anesthetic action of a member of the aliphatic hydrocarbons. In addition, the chlorine derivative is usually less specific in its action and may affect other tissues of the body in addition to those of the central nervous system; in many cases the chlorine derivative is quite toxic. Thus, chloroform, in addition to its narcotic qualities, may cause liver, heart, and kidney damage.

As a general rule, the unsaturated chlorine derivatives are highly narcotic but less toxic than the saturated derivatives, thus causing degenerative changes in the liver and kidneys less frequently. In the saturated group, the narcotic effect is enhanced with an increase in the number of chlorine atoms. However, there is less relationship between the number of chlorine atoms present and the toxicity of the compound.

In dealing with these chlorinated hydrocarbons, it must be remembered that a toxic action may result from repeated exposure to concentrations which are too low to produce a narcotic effect, and which, consequently, are too low to give warning of danger. Individual susceptibility is also important when poisoning by this group of solvents is being considered. Certain workmen may be seriously affected by concentrations that seem to have no effect on fellow employees in the same exposure.

Disaster Control: Dangerous; when heated to decomposition, they emit highly toxic fumes of phosgene; they can react with oxidizing materials.
Storage and Handling: Section 7

CHLORINATED HYDROCARBONS, AROMATIC

Toxicology: In most instances it is difficult to predict the toxicity of these compounds. However, in

the case of most aromatic chlorine compounds, their toxicity is usually no greater, and frequently is less, than that of the corresponding aromatic hydrocarbons, with the notable exception of naphthalene.
Fire Hazard: Unknown
Explosion Hazard: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, they may emit toxic fumes; they can react with oxidizing materials.
Storage and Handling: Section 7

CHLORINATED LIME. See Calcium Hypochlorite.

CHLORINATED NAPHTHALENES

Toxic Hazard Rating:
  Acute Local: Irritant 3
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: Irritant 3
  Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Toxicology: The action of the chlorinated naphthalenes on the body is quite similar to that of the chlorinated diphenyls, the chief effects being the production of chloracne of the skin and, systemically, an acute yellow atrophy of the liver. See also Chlorinated Diphenyls.
Disaster Control: Dangerous; when heated to decomposition, they emit highly toxic fumes of chlorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label (for tri and higher.

CHLORINATED PHENOLS

Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
  Chronic Local: U
  Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Disaster Control: Dangerous; when heated to decomposition, they emit highly toxic fumes.
Ventilation Control (use moderate rate).

CHLORINATED TRIPHENYLS

Toxic Hazard Rating:
  Acute Local: Irritant 2
  Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
  Chronic Local: Irritant 3
  Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Disaster Control: Dangerous; when heated to decomposition, they emit highly toxic fumes of chlorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

CHLORINE

Description: Greenish-yellow gas, liquid, or rhombic crystals.
Formula: Cl_2
Constants:
  Mol. Wt. 70.914
  M. P. −101°C
  B. P. −34.5°C
  Density (liquid) 1.47 @0°C (3.65 atmos.)
  Vap. Press. 4800 mm @20°C
  Vap. D. 2.49
Toxic Hazard Rating:
  Acute Local: Irritant 3; Inhalation 3
  Acute Systemic: 0
  Chronic Local: U
  Chronic Systemic: U
MAC: ACGIH (accepted); 1 part per million in air; 2.9 milligrams per cubic meter of air.
Toxicology: Chlorine is extremely irritating to the mucous membranes of the eyes and respiratory tract. It combines with moisture to liberate nascent oxygen and form hydrochloric acid. Both these substances, if present in quantity, cause inflammation of the tissues with which they come in contact. If the lung tissues are attacked, pulmonary edema may result. A concentration of 3.5 ppm produces a detectable odor; 15 ppm causes immediate irritation of the throat. Concentrations of 50 ppm

are dangerous for even short exposures. 1,000 ppm may be fatal, even where the exposure is brief.

Because of its intensely irritating properties, severe industrial exposure seldom occurs, as the workman is forced to leave exposure before he can be seriously affected. In cases where this is impossible, the initial irritation of the eyes and mucous membranes of the nose and throat is followed by cough, a feeling of suffocation, and later, pain and a feeling of constriction in the chest. If exposure has been severe, pulmonary edema may follow, with rales being heard over the chest.

Radiation Hazard (Section 5): Artificial isotope Cl^{36}, half-life 4.0 $\times 10^5$ years; emits beta particles of 0.71 mev and many gamma rays between 0.1-0.6 mev. The permissible levels are: In body: 200 microcuries. In air: 4×10^{-7} microcurie per milliliter. In water: 2×10^{-3} microcurie per milliliter.

Fire Hazard: Moderate; can react to cause fires or explosions upon contact with turpentine, ether, ammonia gas, illuminating gas, hydrocarbons, hydrogen and powdered metals (Section 6).

Explosion Hazard: Slight, by reaction with reducing agents.

Disaster Control: Dangerous; shock can shatter the compressed gas container with explosive force; when heated, it emits highly toxic fumes; will react with water or steam to produce toxic and corrosive fumes of hydrogen chloride.

Ventilation Control (use moderate rate): Section 2

Personal Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

Shipping Regulations: Section 11.

I. C. C. Classification: Nonflammable gas; green label.

Coast Guard Classification: Nonflammable gas; green gas label.

MCA warning label.

CHLORINE AZIDE

Synonym: Chlor (o)azide

Description: Gas

Formula: ClN_3

Constant:

Mol. Wt. 77.48

Toxic Hazard Rating:

Acute Local: Irritant 3; inhalation 3

Acute Systemic: Inhalation 3

Chronic Local: U

Chronic Systemic: U

Explosion Hazard: Severe, when shocked or exposed to heat or flame.

Disaster Control: Dangerous; shock can explode and shatter the container with explosive force; when heated to decomposition, it emits highly toxic fumes of chlorine and oxides of nitrogen; will react with water or steam to produce toxic and corrosive fumes of hydrogen chloride.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

CHLORINE DIOXIDE

Description: Red-yellow gas or orange-red crystals.

Formula: ClO_2

Constants:

Mol. Wt. 67.5

M. P. −59°C

B. P. 9.9°C @731 mm

Density 3.09 g/liter @11°C

Vap. D. 2.32

Toxic Hazard Rating:

Acute Local: Irritant 3; Ingestion 3; Inhalation 3

Acute Systemic: U

Chronic Local: Irritant 3

Chronic Systemic: U

Fire Hazard: Dangerous; a powerful oxidizer (Section 6).

Explosion Hazard: Severe, when heated to 100°C or by chemical reaction.

Disaster Control: Dangerous; shock will explode it; when heated to decomposition, it emits highly toxic fumes of chlorine; will react with water or steam to produce toxic and corrosive fumes of hydrochloric acid; can react

vigorously with reducing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

CHLORINE HEPTAOXIDE
Description: Colorless oil.
Formula: Cl_2O_7
Constants:
  Mol. Wt. 182.91
  M. P. −91.5°C
  B. P. 82°C
  Vap. Press. 100 mm @29.1°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Dangerous; a very powerful oxidizing agent (Section 6).
Explosion Hazard: Severe, when shocked or exposed to heat or flame.
Disaster Control: Dangerous; shock or heat will explode it; on decomposition, it emits highly toxic fumes of chlorine; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

CHLORINE HYDRATE
Description: Rhombic light yellow crystals.
Formuls: $Cl_2 \cdot 8H_2O$
Constants:
  Mol. Wt. 215.04
  M. P. Decomposes 9.6°C
  Density 1.23
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorine; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

CHLORINE MONOFLUORIDE
Description: Nearly colorless gas.
Formula: ClF
Constants:
  Mol. Wt. 54.46
  M. P. −154 ± 0.5°C
  B. P. − 100.8°C
  Density 1.62 @−100°C
Toxicity: See Fluorides and Chlorine.

CHLORINE MONOXIDE
Description: Yellow-red gas or red-brown liquid.
Formula: Cl_2O
Constants:
  Mol. Wt. 86.91
  M. P. −20°C
  B. P. 2.2°C
  Density 3.89 @0°C g/liter
Toxicity: See Chlorine.
Explosion Hazard: Severe, when shocked or exposed to heat.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorine and explodes; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

CHLORINE TETROXIDE
Synonym: Hypochlorous anhydride.
Description: Gas.
Formula: ClO_4 or Cl_2O_8
Constants:
  Mol. Wt. 99.46
  B. P. Decomposes
Toxicity: See Chlorine.
Fire Hazard: Moderate; a powerful oxidizer.
Explosion Hazard: Moderate, when exposed to heat.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorine; will react with water or steam to

produce toxic and corrosive fumes; on contact with acid fumes, it can emit flammable vapors.
Storage and Handling: Section 7

CHLORINE TRIFLUORIDE

Description: Colorless gas to yellow liquid, sweet odor.
Formula: ClF_3
Constants:
Mol. Wt. 92.46
M. P. -83°C
B. P. 11.8°C
Density 1.77 @13°C
Vap. D. 3.14
Toxicity: See Fluorides.
MAC: ACGIH (tentative): 0.1 parts per million of air.
Fire Hazard: Dangerous. Spontaneously flammable. It ignites on contact with many organic compounds, and reacts violently with oxidizable materials, metals, etc. (Section 6).
Disaster Control: Dangerous; shock can shatter the compressed gas container with explosive force; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes; will react with water or steam to produce much heat and toxic and corrosive fumes; reacts vigorously with reducing materials.
Ventilation Control (use moderate rate).
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

CHLOROACETALDEHYDE

Synonym: Chloroaldehyde.
Description: Clear, colorless liquid; pungent odor.
Formula: C_2H_3OCl
Constants:
Mol. Wt. 78.5
B. P. 90.0 - 100.1°C (40% sol.)
Freezing P. -16.3°C (40% sol.)
Flash P. 190°F
Density 1.19 @25°/25°C (40% sol.)
Vap. Press. 100 mm @45°C (40% sol.)
Vap. D. 2.7
Toxicity: See Aldehydes.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; reacts with oxidizing materials.
Storage and Handling: Section 7

CHLOROACETIC ACID. See Monochloroacetic Acid.

CHLOROACETONE

Synonym: Chlorinated acetone.
Description: Colorless liquid; pungent odor.
Formula: CH_3COCH_2Cl
Constants:
Mol. Wt. 92.53
M. P. -44.5°C
B. P. 119°C
Density 1.162
Toxicity: See Chlorinated Hydrocarbons, Aliphatic and Acetone.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of phosgene; can react vigorously with oxidizing materials.
Storage and Handling: Section 7·

CHLOROACETONITRILE

Description: Crystals.
Formula: CH_2ClCN
Constant:
Mol. Wt. 75.5
Toxicity: See Cyanides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; will react with water, steam, acid or acid fumes to produce toxic and flammable vapors.
Storage and Handling: Section 7

CHLOROACETOPHENONE

Synonyms: Phenacylchloride; phenylchloromethylketone.
Description: Pale straw-colored liquid or white crystals; fragrant, non-persistent odor.
Formula: C_8H_7ClO

Constants: Mol. Wt. 154.6
M. P. 56°C
B. P. 237 - 247°C
Freezing P. 59°C
Density 1.19 @25°/25°C
Vap. Press. 0.012 mm @0°C
Vap. D. 5.2
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Caution: A lachrymator type of military poison.
Disaster Control: Dangerous; shock can shatter the container and release a poisonous gas; when heated to decomposition, it emits toxic fumes; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11
I. C. C. Classification: Poison C; tear gas label (gas, liquid or solid).
Coast Guard Classification: Poison C; tear gas label (gas, liquid or solid.

CHLOROACETYL CHLORIDE

Description: Water-white or slightly yellow liquid.
Formula: $CH_2ClCOCl$
Constants:
Mol. Wt. 112.95
B. P. 105 - 106°C
Freezing P. −22.5°C
Flash P. None
Density 1.495 @0°C
Toxicity: See Hydrochloric Acid.
Caution: A lachrymator (tear gas).
Ventilation Control (use moderate rate).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

CHLOROACROLEIN

Description: Colorless liquid.
Formula: $CH_2CClCHO$
Constants:
Mol. Wt. 90.52
B. P. 30°C
Density 1.205 @15°C
Toxic Hazard Rating:
Acute Local: Irritant 3, Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Caution: A poison gas.
Disaster Control: Dangerous; shock can shatter the container and release the contents; when heated to decomposition, it emits highly toxic fumes; will react with water or steam to produce toxic and corrosive fumes.
Ventiliation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

2-CHLORO-4-tert-AMYL PHENOL

Description: Liquid
Formula: $HOC_6H_3ClC_5H_{11}$
Constants: Mol. Wt. 198.7
B. P. 487 - 509°F
Flash P. 225°F
Density 1.11
Toxicity: Details unknown
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits highly toxic fumes; reacts with oxidizing materials.
Storage and Handling: Section 7

m-CHLOROANILINE

Description: Liquid
Formula: C_6H_6ClN
Constants:
Mol. Wt. 127.6
M. P. −10°C
B. P. 228.5°C
Density 1.223 @15°/15°C
Vap. Press. 1 mm @63.5°C
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: Ingestion 3;

Inhalation 3; Skin Absorption 3
Chronic Local: Allergen 1
Chronci Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

o-CHLOROANILINE

Description: Liquid.
Formula: C_6H_6ClN
Constants: Mol. Wt. 127.6
M. P. −14°C or −3.5°C (2 forms)
B. P. 209°C
Density 1.213 @20°/4°C
Vap. Press. 1 mm @46.3°C
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: Allergen 1
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of aniline and chlorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

p-CHLOROANILINE

Description: Crystalline solid.
Formula: C_6H_6ClN
Constants: Mol. Wt. 127.6
M. P. 70 - 71°C
B. P. 230.5°C
Density 1.427
Vap. Press. 1 mm @59.3°C
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Allergen 1
Chronic Systemic: Ingestion 3; Inhalation 3
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of aniline and chlorides.
Ventilation Control: (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

β - (o-CHLOROANILINO) PROPIONITRILE

Description: Colorless to red (on aging) liquid.
Formula: $ClC_6H_4NHCH_2CH_2CN$
Constants: Mol. Wt. 180.6
B. P. 139 - 141°C @0.3 mm
Density 1.2103 @25°/25°C
Vap. D. 6.23
Toxicity: See Cyanides.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Ventilation Control (use moderate rate).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of hydrogen cyanide; will react with water, steam, acid or acid fumes to produce toxic and flammable vapors of cyanides.
Storage and Handling: Section 7

CHLOROAURIC ACID

Description: Bright yellow needles; deliquescent.
Formula: $HAuCl_4 \cdot 4H_2O$
Constants: Mol. Wt. 412.10
M. P. Decomposes
Toxicity: See Gold Compounds and Hydrochloric Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

CHLOROBENZENE

Synonyms: Phenyl chloride; monochlorobenzene; chlorobenzol.
Description: Clear, colorless liquid.
Formula: C_6H_5Cl
Constants:
Mol. Wt. 112.56
B. P. 131.7°C
Freezing P. −55.6°C
Flash P. 85°F (C.C.)
Density 1.113 @15.5°/15.5°C
Autoign. Temp. >1245°F
Vap. Press. 10 mm @22.2°C
Vap. D. 3.88
Toxic Hazard Rating:
Acute Local: Irritant 1;

Ingestion 1; Inhalation 1
Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 1
Chronic Local: 0
Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2

MAC: ACGIH (accepted); 347 milligrams per cubic meter of air; 75 parts per million in air.

Toxicology: Monochlorobenzol is a fairly strong narcotic and posses-ses only slight irritant qualities. For cats, concentrations of 1,200 ppm are quite narcotic, and concentrations of 3,700 ppm are fatal after several hours. The dichlorobenzols are strongly narcotic, 1,000 ppm causing narcosis in guinea pigs followed by death after 20 hours exposure. Knowledge of the effects on man of repeated exposure to subnarcotic concentrations is meagre. In general, it appears that the chlorobenzols are not as toxic as benzol. Some of the symptoms described (methemoglobinemia) suggest that other substances such as nitrobenzol, may have been partially responsible for the few cases of industrial illness reported. It is possible that prolonged exposure to chlorobenzol may cause kidney and liver damage.

Somnolence, loss of consciousness, twitchings of the extremities, cyanosis, deep, rapid respirations and a small, irregular pulse are the chief symptoms occuring in acute exposures. The urine may be burgundy red, and the red blood cells show degenerative and regenerative changes.

Fire Hazard: Dangerous, when exposed to heat or flame.

Spontaneous Heating: No

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Moderate, when exposed to heat or flame.

Explosive Range: 1.8%@ 212°F to 9.6% @302°F

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorine compounds; can react vigorously with oxidizing materials.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations: Section 11.
I.C.C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid.
MCA warning label

p-CHLOROBENZENE SULFONAMIDE

Description: Crystals.
Formula: $ClC_6H_4SO_2NH_2$
Constant:
Mol. Wt. 191.6
Toxicity: See Chlorinated Hydrocarbons, Aromatic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur and chlorides.
Storage and Handling: Section 7

p-CHLOROBENZENE SULFONYL FLUORIDE

Description: White solid.
Formula: $ClC_6H_4SO_2F$
Constants:
Mol. Wt. 195
M. P. 46 - 51°C
B. P. 229 - 230°C
Flash P. 340°F
Density 1.475
Vap. Press. 11 mm @100°C
Vap. D. 6.73
Toxicity: Does not appear to be highly toxic to test animals by inhalation on an acute basis. May be slightly irritating to the skin.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides, chlorides and oxides of sulfur; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

CHLOROBENZONITRILES (o, p)

Description: Crystals.
Formula: ClC_6H_4CN
Constant:
Mol. Wt. 137.6

Toxicity: See Cyanides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of cyanides and chlorides; it will react with water steam, acid or acid fumes to produce toxic fumes.
Storage and Handling: Section 7

m-CHLOROBENZOTRIFLUORIDE

Synonym: m-Chlorotrifluoromethylbenzene.
Description: Water-white aromatic liquid.
Formula: $ClC_6H_4CF_3$
Constants:
Mol. Wt. 180.56
M. P. -56°C
B. P. 138°C
Density 1.35_1
Vap. D. 6.24
Toxicity: See Fluorides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it can emit highly toxic fumes.
Storage and Handling: Section 7

p-CHLOROBENZOTRIFLUORIDE

Synonym: p-Chlorotrifluoromethylbenzene.
Description: Clear water-white liquid.
Formula: $ClC_6H_4CF_3$
Constants:
Mol. Wt. 180.56
M. P. -36°C
B. P. 139.3°C
Flash P. 116°F
Density 1.353 @15.5°/15.5°
Vap. D. 6.24
Toxicity: See Fluorides.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, or on contact with acid or acid fumes, it emits highly toxic fumes of chlorides and fluorides; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

p-CHLOROBENZOYL PEROXIDE

Toxicity: See Peroxides, Organic.
Fire Hazard: Moderate; an oxidizing agent (Section 6).
Disaster Control: Dangerous, when heated to decomposition, it emits highly toxic fumes; can react vigorously with reducing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material (dry or wet); yellow label.

o-CHLOROBENZYL CHLORIDE

Description: A colorless liquid or crystals.
Formula: $ClC_6H_4CH_2Cl$
Constants:
Mol. Wt. 161.08
B. P. 216 - 222°C
Freezing P. < -30°C
Density 1.270-1.280 @25°/15°C
Vap. D. 5.55
Toxicity: Details unknown.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene.
Storage and Handling: Section 7

p-CHLOROBENZYL CHLORIDE

Synonym: alpha, 4-Dichlorotoluene.
Description: Needle-like crystals or colorless liquid.
Formula: $ClC_6H_4CH_2Cl$
Constants:
Mol. Wt. 161.0
M. P. 29°C
B. P. 222°C
Density 1.250-1.260 @25°/15°C
Vap. D. 5.55
Toxicity: Details unknown.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene.
Storage and Handling: Section 7

2-CHLORO-4, 6-BIS-(DIETHYLAMINE)-3-TRIAZINE

Description: Clear liquid; slight odor.
Formula: $C_8H_{20}N_5Cl$
Constants:
Mol. Wt. 221.75
M. P. 27°C
Density 1.0956
Toxicity: Details unknown.
Disaster Control: Moderately dangerous; when heated to

decomposition, it emits toxic fumes.
Storage and Handling: Section 7

CHLOROBROMOMETHANE
Synonyms: Bromchloromethane.
Description: Clear, colorless, heavy volatile liquid.
Formula: CH_2ClBr
Constants:
Mol. Wt. 129.4
M. P. −88°C
B. P. 68°C
Flash P. None
Density 1.923 @25°/4°C
Vap. Press. 147 mm @25°C
Toxicity: See Halogenated Hydrocarbons.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chloro and bromophosgene.
Storage and Handling: Section 7

CHLOROBROMOPHOSGENE
Description: Liquid.
Formula: COClBr
Constants:
Mol. Wt. 143.39
B. P. 25°C
Density 1.82 @15°C
Toxicity: See Carbon Oxychloride.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene.
Storage and Handling: Section 7

CHLOROBUTADIENE. See Chloroprene.

CHLOROBUTANOL
Synonym: Acetone chloroform.
Description: Crystals, camphor odor.
Formula: $Cl_3CC(CH_3)_2OH$
Constants:
Mol. Wt. 177.5
M. P. 97°C
B. P. 167°C
Toxicity: Details unknown.
Fire Hazard: Slight; when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene; can react with oxidizing materials.
Storage and Handling: Section 7

2-CHLOROBUTENE-2
Description: Liquid.
Formula: ClC_4H_7
Constants:
Mol. Wt. 90.6
B. P. 143°F
Flash P. −14°F
Toxicity: Details unknown.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use moderate rate).
Disaster Control: Dangerous, when heated to decomposition, it emits highly toxic fumes of phosgene; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

o-CHLOROCINNAMIC ACID
Description: Light tan powder.
Formula: $ClC_6H_4CHCHCOOH$
Constants:
Mol. Wt. 182.6
M. P. 207 - 212°C
Toxicity: Details unknown.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene.
Storage and Handling: Section 7

p-CHLORO-m-CRESOL
Synonym: 4-Chloro-3-hydroxy toluene.
Description: Crystals; phenolic odor.
Formula: C_7H_7ClO
Constants:
Mol. Wt. 142.6
M. P. 46°C
B. P. 196°C
Toxicity: Details unknown. An allergen.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene.
Storage and Handling: Section 7

CHLOROCYANOHYDRIN
Synonym: Chloral hydrocyanide.
Description: Crystals; odor of chloral and hydrogen cyanide.
Formula: $CCl_3CH(OH)CN$
Constants:
Mol. Wt. 174.4
M. P. 61°C
B. P. 220°C

Toxicity: See Cyanides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of cyanides; will react with water, steam, acid or acid fumes to produce toxic fumes.
Storage and Handling: Section 7

1-CHLORO-1,1-DIFLUOROETHANE
Description: Gas.
Formula: $ClF_2C_2H_3$
Constant:
Mol. Wt. 100.50
Toxicity: Details unknown.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and fluorides.
Storage and Handling: Section 7

CHLORODIFLUOROMETHANE. See "Freon-22".

2-CHLORO-4-DIMETHYLAMINO-6-METHYL PYRIMIDINE
Toxicity: Details unknown; a rodenticide.
Fire Hazard: Slight; when heated, it emits toxic fumes.
Storage and Handling: Section 7

2,1,4-CHLORODINITROBENZENE
Synonyms: Dinitrochlorobenzol; dinitrochlorobenzene.
Description: Colorless needles.
Formula: $C_6H_3(NO_2)_2Cl$
Constants: Mol. Wt. 202.57
M. P. 47 - 53°C
B. P. 315°C
Density 1.69
Toxicity: See Chloronitrobenzene.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of nitrogen; it can react with oxidizing materials.
Storage and Handling: Section 7

CHLORODIPHENYL. See Chlorinated Diphenyls.

CHLORODIPHENYL OXIDE. See Chlorinated Diphenyl Oxide.

2-CHLOROETHANOL. See Ethylene Chlorohydrin.

CHLOROETHYL ACETATE. See Ethyl Chloroacetate.

1-CHLORO-4-ETHYLBENZENE
Description: Clear, colorless liquid.
Formula: $ClC_6H_4CH_2CH_3$
Constants:
Mol. Wt. 140.6
M. P. -62.6°C
B. P. 184.3°C
Flash P. 147°F
Density 1.05 @25°/25°C
Vap. Press. 1 mm @ 19.2°C
Vap. D. 4.86
Toxicity: Details unknown.
Fire Hazard: Moderate, when exposed to heat or flame; reacts with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

β-CHLOROETHYLCHLOROFORMATE
Description: Colorless liquid.
Formula: $COClOCH_2CH_2Cl$
Constants:
Mol. Wt. 142.99
B. P. 152.5°C (752 mm)
Density 1.3825 @20°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Moderately dangerous; when heated to decomposition, it emits highly toxic fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

β-CHLOROETHYL CHLOROSULFONATE
Description: Chloropicrin-like odor.
Formula: $ClCH_2CH_2OSO_2Cl$
Constants:
Mol. Wt. 179.04
B. P. 101°C (23 mm)
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3

Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of sulfur.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

CHLOROETHYLENE. See Vinyl chloride.

2-CHLOROETHYL ETHER
Description: Liquid.
Formula: $(ClC_2H_4)_2O$
Constant:
Mol. Wt. 143
Toxicity: Details unknown.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: See Ethers.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react with oxidizing materials.
Storage and Handling: Section 7

2-CHLOROETHYL VINYL ETHER
Description: Liquid.
Formula: $CH_2ClCH_2OCHCH_2$
Constants:
Mol. Wt. 106.55
B. P. 104 - 108°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: See Ethers.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

2-CHLOROFLUORENE
Toxicity: Details unknown.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

CHLOROFORM
Synonym: Trichloromethane.
Description: Colorless liquid; heavy, ethereal odor.
Formula: $CHCl_3$
Constants:
Mol. Wt. 119.39
M. P. −63.5°C
B. P. 61.26°C
Freezing P. −63.5°C
Flash P. None
Density 1.49845 @15°C
Vap. Press. 100 mm @10.4°C
Vap. D. 4.12
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: Inhalation 3
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (accepted): 100 parts per million in air; 487 milligrams per cubic meter of air.
Toxicology: Chloroform causes irritation of the conjunctiva. Upon inhalation, it causes dilation of the pupils with reduced reaction to light, as well as reduced intraocular pressure (experimental). The material is well known as an anesthetic. In the initial stages there is a feeling of warmth of the face and body, then an irritation of the mucous membranes and skin followed by nervous aberration. Prolonged inhalation will bring on paralysis accompanied by cardiac and respiratory failure and finally death.

It has been widely used as an anesthetic. However, due to its toxic effects, this use is being abandoned. 68,000 to 82,000 ppm kill most animals in a few minutes. 14,000 ppm is dangerous to life after an exposure of from 30 to 60 minutes. 5,000 to 6,000 ppm can be tolerated by animals for one hour without serious disturbances. The maximum concentration tolerated for several hours or for prolonged exposure with slight symptoms is 2,000 to 2,500 ppm. The harmful effects are narcosis, and damage to the liver and heart. Prolonged administration as an anesthetic may lead to such serious effects as profound toxemia and damage to the liver, heart and kidneys. Experimentally prolonged but light anesthesia in dogs produces a typical hepatitis. Inhalation of the concentrated chloroform vapor results in irritation of the mucous surfaces exposed to it. The narcosis is ordinarily preceded by a stage of excitation which is followed by loss of reflexes, sensation, and consciousness.

Treatment and Antidotes: If it has been ingested, or there has been great overexposure, the following antidotes may be applied; emetics, stomach syphon, friction, cold douche, fresh air, strychnine (hypodermically - from $^1/_{120}$ to $^1/_{60}$ grain), rubefactions, artificial respiration, etc. If during exposure to unknown amounts of chloroform vapor, the patient should feel any of the symptoms noted above, he should immediately be moved to fresh air and kept under observation until the symptoms disappear.

Fire Hazard: Slight, when exposed to high heat; otherwise practically nonflammable (Section 6).

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene.

Ventilation Control (use normal rate): Section 2

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations: Section 11. MCA warning label.

CHLOROFORMOXIME

Description: Needles; odor resembling hydrocyanic acid.

Formula: CClHNOH

Constant:
Mol. Wt. 79.5

Toxic Hazard Rating:
Acute Local: Irritant 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

CHLOROGERMANE

Description: Colorless liquid.

Formula: GeH_3Cl

Constants:
Mol. Wt. 111.08
M. P. −52.0°C
B. P. 28.0°C
Density 1.75 @−52°C

Toxicity: See Hydrochloric Acid and Germanium Compounds.

Fire Hazard: Moderate, when exposed to heat or flame (Section 6).

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; it can react with oxidizing materials.

Storage and Handling: Section 7

CHLOROMETHYL CHLOROFORMATE

Description: Mobile, colorless liquid; penetrating irritating odor.

Formula: $ClCOOCH_2Cl$

Constants:
Mol. Wt. 129
B. P. 106.5 - 107°C
Density 1.465 @15°C

Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

CHLOROMETHYL-4-CHLOROPHENYL SULFONE

Description: Crystals.

Formula: $ClC_6H_4SO_2CH_2Cl$
Constant:
  Mol. Wt. 225.1
Toxicity: Details unknown.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits highly toxic fumes; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

CHLOROMETHYL CHLOROSULFONATE

Description: Colorless liquid.
Formula: $ClCH_2OClSO_2$
Constants:
  Mol. Wt. 165.01
  B. P. 49 - 50°C (14 mm)
  Density 1.63
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

2-CHLOROMETHYLTHIOPHENE

Description: Crystals.
Formula: $C_4H_3SCH_2Cl$
Constant:
  Mol. Wt. 132.6
Toxicity: Details unknown. See also Hydrochloric Acid which is liberated by this material upon storage.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: Severe, when shocked, exposed to heat or by spontaneous chemical reaction.
Disaster Control: Dangerous, shock will explode it; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of sulfur; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

CHLORONAPHTHALENE. See Chlorinated Naphthalenes.

o-CHLORO-p-NITROANILINE

Synonym: OCPN.
Description: Yellow crystalline powder.
Formula: $O_2NC_6H_3(Cl)NH_2$
Constants:
  Mol. Wt. 172.6
  M. P. 108.4°C
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: Allergen 1
  Chronic Systemic: Ingestion 3; Inhalation 3
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, or on contact with acid or acid fumes, it emits highly toxic fumes; it can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

p-CHLORO-o-NITROANILINE

Description: Orange crystalline powder.
Formula: $ClC_6H_3(NO_2)NH_2$
Constants:
  Mol. Wt. 172.6
  M. P. 116.3°C
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: Allergen 1
  Chronic Systemic: Ingestion 3; Inhalation 3
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

First Aid: Section 1
Storage and Handling: Section 7

m-CHLORONITROBENZENE
Synonym: 1-Chloro-3-nitrobenzene.
Description: Yellowish crystals.
Formula: $ClC_6H_4NO_2$
Constants:
  Mol. Wt. 157.6
  M. P. 46°C
  B. P. 236°C
  Density 1.534 @20°/4°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: Ingestion 3; Inhalation 3
Toxicology: Intoxication from this material can be serious. When absorbed, it forms methemoglobin and gives rise to cyanosis and blood changes. Its effects are analogous to those of nitrobenzene. It can cause poisoning by the pulmonary route and its effects are cumulative. Chemically, it is probably reduced in the body to chloroaniline, which is also poisonous. The para compound is thought to be somewhat less toxic than the ortho compound. In industry it is the dust of this material that is most often the source of intoxication.
Treatment and Antidotes: Removal from exposure is important as soon as the symptoms appear. If cyanosis is evident, administer oxygen and call a physician as soon as possible. If breathing has stopped, give artificial respiration.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen and phosgene; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

o-CHLORONITROBENZENE
Synonym: o-Nitrochlorobenzene.
Description: Yellow crystals.
Formula: $C_6H_4ClNO_2$
Constants:
  Mol. Wt. 157.6
  M. P. 32 - 33°C
  B. P. 245 - 246°C
  Density 1.368
Toxicity: See m-Chloronitrobenzene.
Fire Hazard: See m-Chloronitrobenzene.
Disaster Control: See m-Chloronitrobenzene.
Storage and Handling: Section 7

p-CHLORONITROBENZENE
Synonym: 4-Chloro-1-nitrobenzene.
Description: Yellow crystals.
Formula: $C_6H_4ClNO_2$
Constants:
  Mol. Wt. 157.6
  M. P. 83°C
  B. P. 242°C
  Flash P. 127°C
  Density 1.520
Toxicity: See m-Chloronitrobenzene.
Fire Hazard: Moderate, when exposed to heat.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: See m-Chloronitrobenzene.
Storage and Handling: Section 7

2-CHLORO-5-NITROBENZOTRIFLUORIDE
Description: Liquid.
Formula: $C_7H_3F_3ClNO_2$
Constants:
  Mol. Wt. 225.6
  B. P. 231.9°C
  Flash P. 275°F
  Density 1.504 @30°/4°C
  Vap. D. 7.8
Toxicity: See m-Chloronitrobenzene and Fluorides.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

4-CHLORO-3-NITROBENZOTRIFLUORIDE
Description: Liquid.

Formula: $C_7H_3F_3ClNO_2$
Constants:
Mol. Wt. 225.6
B. P. 222.6°C
M. P. −2.5°C
Toxicity: See m-Chloronitrobenzene and Fluorides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.
Storage and Handling: Section 7

1-CHLORO-1-NITROETHANE

Description: Liquid.
Formula: $CH_3CHCl(NO_2)$
Constants:
Mol. Wt. 109.5
B. P. 129°C
Flash P. 133°F
Density 1.258 @20°/20°C
Vap. D. 3.77
Toxicity: See 1-Chloro-1-Nitropropane.
Fire Hazard: Moderate, when exposed to heat.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when shocked or exposed to heat or flame.
Disaster Control: Dangerous; shock will explode it; when heated to decomposition, it emits highly toxic fumes of phosgene and oxides of nitrogen; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

1-CHLORO-1-NITROPROPANE

Description: Liquid.
Formula: $CH_3CH_2CH(NO_2)Cl$
Constants:
Mol. Wt. 123.5
B. P. 139.5°C
Flash P. 144°F
Density 1.209 @20°/20°C
Vap. D. 4.26
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (accepted); 20 parts per million in air; 101 milligrams per cubic meter of air.
Fire Hazard: Moderate, when exposed to heat.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes and explodes; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

2-CHLORO-2-NITROPROPANE

Description: Liquid.
Formula: $CH_2CCl(NO_2)CH_3$
Constants:
Mol. Wt. 123.5
B. P. 134°C
Flash P. 135°F
Density 1.197 @20°/20°C
Vap. D. 4.26
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation: 3
Chronic Local: U
Chronic Systemic: U
Fire Hazard: See Nitrates.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Personnel Protection: Section 3
Ventilation Control (use moderate rate).
First Aid: Section 1
Storage and Handling: Section 7

2-CHLORO-6-NITROTOLUENE

Description: Liquid.
Formula: $C_7H_6NO_2Cl$
Constant:
Mol. Wt. 171.6
Toxicity: See Trinitrotoluene.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

2-CHLORO-5-NITROTRIFLUOROMETHYLBENZENE. See m-Chloronitrobenzene and Fluorides.

CHLOROPENTAMMINE CHROMIUM (III) CHLORIDE

Description: Red crystals.
Formula: $[Cr(NH_3)_5Cl]Cl_2$
Constants:
Mol. Wt. 243.54
Density 1.696
Toxicity: See Chromium Compounds.
Fire Hazard: Slight, when heated, it emits toxic fumes.
Storage and Handling: Section 7

CHLOROPENTAMMINECOBALT (III) CHLORIDE

Synonym: Purpureo
Description: Rhombic dark-red violet crystals.
Formula: $[Co(NH_3)_5Cl]Cl_2$
Constants:
Mol. Wt. 250.47
M. P. Decomposes
Density 1.819 @25°/25°C
Toxicity: See Cobalt Compounds.

m-CHLOROPHENOL

Description: Crystals.
Formula: C_6H_4ClOH
Constants:
Mol. Wt. 128.6
M. P. 32.5°C
B. P. 214°C
Density 1.245
Vap. Press. 1 mm @44.2°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Irritant 2
Chronic Systemic: Ingestion 3; Inhalation 3
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
MCA warning label.

o-CHLOROPHENOL

Description: Light amber liquid.
Formula: C_6H_4OHCl
Constants:
Mol. Wt. 128.6
B. P. 174.5°C
Freezing P. 7°C
Density 1.256 @25°/25°C
Flash P. 185°F
Vap. Press. 1 mm @12.1°C
Toxicity: See Chlorinated Phenols.
Fire Hazard: Moderate, when exposed to heat (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phenol and chlorides; it can react with oxidizing materials.
Ventilation Control (use moderate rate).
Storage and Handling: Section 7
MCA warning label.

p-CHLOROPHENOL

Description: Needle-like, white to straw-colored crystals; unpleasant odor.
Formula: C_6H_4ClOH
Constants:
Mol. Wt. 128.6
B. P. 220°C
Freezing P. 42.8°C
Flash P. 250°F
Density 1.246 @60°/25°C
Vap. Press. 1 mm @49.8°C
Toxicity: See Chlorinated Phenols.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and phenol.
Ventilation Control (use moderate rate).
Storage and Handling: Section 7
MCA warning label.

p-CHLOROPHENOXYETHOXYETHYL CHLORIDE

Toxicity: See Chlorinated Hydrocarbons, Aromatic.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

CHLOROPHENYL CARBAMATE

Description: Crystals.
Formula: $ClC_6H_4NHCOOH$
Constant:
Mol. Wt. 171.6
Toxicity: Details unknown.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

p-CHLOROPHENYL-p-CHLOROBENZENE SULFONATE

Synonyms: K-101; Kolker acaricide.
Description: White to cream, free flowing powder.
Formula: $C_{12}H_8Cl_2OSO_3$
Constants:
Mol. Wt. 319.2
M. P. 81 - 83°C
Toxicity: Details unknown.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of sulfur.
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

o-CHLOROPHENYL DIPHENYL PHOSPHATE

Description: Clear, pale straw colored mobile liquid.
Formula: $C_{18}H_{14}O_4ClP$
Constants:
Mol. Wt. 360.73
M. P. < 0°C
B. P. 240 - 255°C @5 mm
Flash P. > 419°F
Density 1.3 @25°/25°C
Vap. D. 12.5
Toxicity: Details unknown.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of phosphorus; it can react with oxidizing materials.
Storage and Handling: Section 7

1-(p-CHLOROPHENYL)-5-ISOPROPYL-BIGUANIDE HYDROCHLORIDE. See Chlorguanide.

CHLORO-2-PHENYLPHENOL. See 2-Chloro-4-phenylphenol.

2-CHLORO-4-PHENYLPHENOL

Description: White flakes.
Formula: $C_6H_5C_6H_3OHCl$
Constants:
Mol. Wt. 204.6
B. P. 322°C (decomposes)
Freezing P. 74.2°C
Flash P. 345°F
Toxicity: Details unknown. Toxic when taken orally.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous.
Storage and Handling: Section 7

4 and 6-CHLORO-2-PHENYLPHENOL

Description: Clear, colorless to straw-colored, viscous liquid.
Formula: $C_6H_5C_6H_3OHCl$
Constants: Mol. Wt. 204.6
B. P. 162 - 178°C @10 mm
Flash P. 325°F
Density 1.234 @25°/25°C
Vap. D. 7.07
Toxicity: Details unknown. Toxic where taken orally.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous.
Storage and Handling: Section 7

CHLOROPICRIN

Synonym: Nitrotrichloromethane.
Description: Slightly oily, colorless liquid.
Formula: CCl_3NO_2
Constants: Mol. Wt. 164.39
M. P. -64°C
B. P. 112°C
Density 1.692
Vap. Press. 40 mm @33.8°C
Vap. D. 5.69
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Toxicology: Chloropicrin is a powerful irritant and affects all body surfaces. It causes lachrymation, vomiting, bronchitis, and pulmonary edema. A concentration of 1 ppm causes a smarting pain in the eyes and therefore in itself constitutes a good warning of exposure. It cause vomiting probably due to swallowing saliva in which small amounts of chloropicrin have dissolved. It is called

vomiting gas and has been extensively used by the military. Its primary lethal effect is to produce lung injury and it is a difficult gas to protect oneself against because it is chemically inert and does not react with the usual chemicals used in gas masks. Four ppm is sufficient to render a man unfit for action and 20 ppm, when breathed from 1 to 2 minutes, causes definite bronchial or pulmonary lesions. Industrially it is used as a warning agent in commercial fumigants. It is more toxic than chlorine but less so than phosgene.

Treatment and Antidotes: Removal from exposure is an immediate necessity. If exposure has been severe, consult a physician.

Disaster Control: Dangerous; shock can shatter the compressed gas container with explosive force; when heated to decomposition, it emits highly toxic fumes.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

Shipping Regulations: Section 11.
  I. C. C. Classification: Poison A; poison gas label.
  Coast Guard Classification: Poison B; poison label.
  MCA warning label.

CHLOROPLATINIC ACID

Description: Red-brown, deliquescent prisms.

Formula: $H_2PtCl_6 \cdot 6H_2O$

Constants:
  Mol. Wt. 518.08
  M. P. 60°C
  Density 2.431

Toxicity: See Platinum Compounds.

Fire Hazard: Slight; when heated, it emits toxic fumes.

Storage and Handling: Section 7

CHLOROPRENE

Synonyms: 2-Chloro-1,3-butadiene; chlorobutadiene.

Description: Colorless liquid.

Formula: $CH_2CHCClCH_2$

Constants:
  Mol. Wt. 88.54
  B. P. 59.4°C
  Density 0.9583

Toxic Hazard Rating:
  Acute Local: Irritant 2; Inhalation 2
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: Ingestion 3; Inhalation 3

MAC: ACGIH (accepted); 25 parts per million of air.

Toxicology: Animal experiments have shown that a concentration of 250 ppm in air is toxic, and a concentration of 75 ppm may be toxic with continued exposure. Exposure to the vapor first causes irritation of the respiratory tract, followed by depression of respiration and, if exposure is continued, asphyxia. The vapor is a central system depressant; in animals it causes severe degenerative changes in the vital organs, particularly the liver and kidneys. Blood pressure is lowered. Lung changes accompany exposure to the higher concentrations. Humans exposed to chloroprene have been reported to develop dermatitis, conjunctivitis, corneal necrosis, anemia, temporary loss of hair, nervousness and irritability.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

1-CHLOROPROPANE-2,3-DIOL

Synonym: alpha-Chlorohydrin.

Description: Colorless liquid.

Formula: $CH_2ClCHOHCH_2OH$

Constants:
  Mol. Wt. 110.54
  B. P. 213°C Decomposes
  Density 1.326

Toxicity: Details unknown.

Fire Hazard: Slight, when exposed to heat or flame (Section 6).

Storage and Handling: Section 7

β-CHLOROPROPIONITRILE

Description: Colorless liquid.

Formula: $ClCH_2CH_2CN$

Constants:
  Mol. Wt. 89.5
  M. P. -51°C
  B. P. 176°C Decomposes
  Flash P. 168°F (C.C.)
  Density 1.1363 @25°C
  Vap. Press. 6 mm @50°C
  Vap. D. 3.09

Toxicity: See Cyanides.

Fire Hazard: Moderate in its liquid form when exposed to heat or flame.

To Fight Fire: Water, foam, carbon dioxide or dry chemical or carbon tetrachloride.

Storage and Handling: Section 7

gamma-CHLOROPROPYLTRICHLOROSILANE

Description: Liquid.

Formula: $ClC_3H_6SiCl_3$

Constants:
  Mol. Wt. 212
  B. P. 180°C
  Density 1.336 @25°

Toxicity: See Hydrochloric Acid and Chlorosilanes.

Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes; it will react with water or steam to produce heat, toxic and corrosive fumes of hydrochloric acid.

Storage and Handling: Section 7

2-CHLOROPYRIDINE

Description: Colorless oily liquid.

Formula: C_5H_4NCl

Constants:
  Mol. Wt. 113.6
  B. P. 170°C
  Density 1.205 @15°C
  Vap. Press. 1 mm @13.3°C
  Vap. D. 3.93

Toxicity: Details unknown. See also Pyridine.

Fire Hazard: Slight, when exposed to heat or flame (Section 6).

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene; it can react with oxidizing materials.

Storage and Handling: Section 7

CHLOROSILANES

Description: A compound of silicon, chlorine and hydrogen where the total number of atoms of chlorine and hydrogen add up to 4.

Formula: SiH_xCl_y (chlorosilane)

Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: Irritant 2
  Chronic Systemic: U

Note: Toxicity based on hydrochloric acid which is formed upon hydrolysis of a chlorosilane.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; it will react with water or steam to produce heat, toxic and corrosive fumes of hydrochloric acid.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

CHLOROSTANNIC ACID

Description: Colorless leaf-like crystals or liquid.

Formula: $H_2SnCl_6 \cdot 6H_2O$

Constants:
  Mol. Wt. 441.6
  M. P. 9°C
  Density 1.93

Toxicity: See Tin Compounds and Hydrochloric Acid.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; will react with water or steam to produce heat and toxic and corrosive fumes of hydrochloric acid.

Storage and Handling: Section 7

N-CHLOROSUCCINIMIDE

Synonym: Succinchlorimide.

Description: White powder; mild odor of chlorine.

Formula: $C_4H_4O_2NCl$

Constants:
  Mol. Wt. 133.5
  M. P. 148 - 149°C

Toxicity: See Hypochlorous Acid.

Disaster Control: See Hypochlorites.

Storage and Handling: Section 7

CHLOROSULFONIC ACID

Synonym: Sulfuric chlorohydrin.

Description: Clear to cloudy, colorless to pale yellow liquid; sharp odor.
Formula: $ClSO_3H$
Constants: Mol. Wt. 116.53
M. P. -80°C
B. P. 151.0°C
Density 1.766 @18°C
Vap. Press. 1 mm @32.0°C
Vap. D. 4.02
Toxicity: See Sulfuric Acid.
Toxicology: Chlorosulfonic acid can cause severe acid burns and is very irritating to the eyes, lungs and mucous membranes. It can cause acute toxic effects either in the liquid or vapor state. Inhalation of concentrated vapor may cause loss of consciousness with serious damage to lung tissue. Contact of liquid with the eyes can cause severe burns if not immediately and completely removed. It also causes severe skin burns due to its highly corrosive action. Upon ingestion, it will irritate the mouth, esophagus and stomach to a serious degree and on contact with skin cause dermatitis. Even in the vapor form it may cause conjunctivitis.
Treatment and Antidotes: Remove exposed patient to fresh air. If his breathing has stopped, institute artificial respiration. He should be kept quiet, comfortably warm but not hot. If coughing ensues, oxygen may furnish relief. Oxygen should be administered for about $\frac{1}{2}$ hour. A physician should be summoned. If the material spills onto the skin, remove contaminated clothing and wash for at least 15 minutes. If it comes into contact with the eyes, they should be irrigated for at least 15 minutes. If taken internally and the patient is still conscious, give milk of magnesia or lime-water. Do not induce vomiting. In any event, a physician should be summoned at once.
Ventilation Control (use moderate rate).
Disaster Control: See Sulfuric Acid and Hydrochloric Acid.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.
MCA warning label.

CHLOROSULFONIC ACID-SULFUR TRIOXIDE MIXTURE. See Chlorosulfonic Acid and Sulfur Trioxide.
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

2-CHLORO-2-TETRACHLOROPHENOXYDIETHYL ETHER

Description: Colorless, odorless liquid.
Formula: $Cl(C_2H_4)_2O_2Cl_4$
Constants:
Mol. Wt. 338.4
M. P. 31°C
B. P. 170 - 176°C @1 mm
Flash P. 392°F
Density 1.506
Vap. D. 11.6
Toxicity: Details unknown.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

CHLOROTHYMOL

Synonym: 6-Chloro-4-isopropyl-1-methyl-3-phenol.
Description: Crystals.
Formula: $C_{10}H_{13}ClO$
Constants:
Mol. Wt. 184.7
M. P. 62 - 64°C
Toxicity: Details unknown.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

m-CHLOROTOLUENE

Synonym: 3-Chloro-1-methylbenzene.
Description: Liquid.
Formula: C_7H_7Cl
Constants:
Mol. Wt. 126.6
M. P. -48°C

B. P. 162.3°C
Density 1.0797 @13.90°/4°C
Vap. Press. 10 mm @43.2°C
Toxicity: Details unknown. Vapor is toxic. Avoid prolonged breathing of vapor. Use with adequate ventilation.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Ventilation Control (moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

o-CHLOROTOLUENE
Synonym: 2-Chloro-1-methylbenzene
Description: Liquid.
Formula: C_7H_7Cl
Constants:
Mol. Wt. 126.6
M. P. -35°C
B. P. 159.3°C
Density 1.1018 @0°/4°C
Vap. Press. 10 mm @43.2°C
Toxicity: Details unknown. Vapor toxic. Avoid prolonged breathing of vapor. Use with adequate ventilation.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Ventilation Control (moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

p-CHLOROTOLUENE
Synonym: 4-Chloro-1-methyl benzene.
Description: Liquid.
Formula: C_7H_7Cl
Constants:
Mol. Wt. 126.6
M. P. 7.3°C
B. P. 162.3°C
Density 1.0651 @24.4°/4°C
Vap. Press. 10 mm @43.8°C
Toxicity: Details unknown. Vapor is toxic. Avoid prolonged breathing of vapor. Use with adequate ventilation.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Ventilation Control (moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

CHLOROTOLUIDINE
Synonym: p-Toluidine hydrochloride.
Description: Grayish-white crystals.
Formula: $C_7H_9N \cdot HCl$
Constants: Mol. Wt. 143.6
M. P. 243°C
B. P. 257.5 (sublimes)
Toxicity: See Toluidine.
Toxicology: May cause cyanosis, tachycardia, hematuria, albuminuria.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

2-CHLORO-1,1,3-TRIETHOXY PROPANE
Description: Liquid.
Formula: $C_9H_{19}O_3Cl$
Constant:
Mol. Wt. 210.70
Toxicity: Details unknown.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Storage and Handling: Section 7

CHLOROTRIFLUOROETHYLENE
Formula: $ClFCCF_2$
Constant:
Mol. Wt. 116.46
Toxicity: Details unknown. See Fluorides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and fluorides.
Storage and Handling: Section 7

CHLOROTRIFLUOROGERMANE
Description: Colorless gas.
Formula: GeF_3Cl
Constants:
Mol. Wt. 165.06
M. P. -66.2°C
B. P. -20.3°C
Toxicity: See Fluorides and Germanium Compounds.
Disaster Control: Dangerous; when heated to decomposition; it emits highly toxic fumes of chlorides and fluorides; will react with water, steam, acid or acid fumes to produce toxic and corrosive fumes.
Storage and Handling: Section 7

β-CHLOROVINYLDICHLOROARSINE
Description: Colorless liquid; geranium-like odor.

Formula: $ClCHCHAsCl_2$
Constants:
  Mol. Wt. 207.4
  B. P. 190°C (decomp.)
  Freezing P. −17.5°C
  Density 1.8855 @20°C
  Vap. Press. 0.4 mm @20°C
  Vap. D. 7.1
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
  Chronic Local: Irritant 3
  Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

β-CHLOROVINYLMETHYLCHLOROARSINE

Description: Liquid.
Formula: $CH_3AsClCHCHCl$
Constants:
  Mol. Wt. 187.0
  B. P. 112 - 115°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
  Chronic Local: Irritant 3
  Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

p-CHLORO-m-XYLENOL

Description: Solid.
Formula: C_8H_9OCl
Constants:
  Mol. Wt. 156
  M. P. 112°C
Toxicity: Details unknown.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Storage and Handling: Section 7

CHROME ALUM

Synonym: Chromium-potassium sulfate.
Description: Dark violet-red crystals.
Formula: $CrK(SO_4)_2 \cdot 12H_2O$
Constants:
  Mol. Wt. 499.3
  Density 1.813
Toxicity: See Chromium Compounds.

CHROME YELLOW

Synonym: Lead chromate.
Description: Lemon-yellow powder.
Formula: $PbCrO_4$
Constants:
  Mol. Wt. 323.2
  M. P. 844°C
  Density 6.3
Toxicity: See Chromium Compounds and Lead Compounds.
Disaster Control: See Lead Compounds.
Storage and Handling: Section 7

CHROMIC ACETATE

Description: Gray-green powder or bluish-green pasty mass.
Formula: $Cr(C_2H_3O_2)_3 \cdot H_2O$
Constant:
  Mol. Wt. 247.16
Toxicity: See Chromium Compounds.

CHROMIC ACID

Synonyms: Chromic anhydride; chromium trioxide.
Description: Dark, purple-red crystals.
Formula: CrO_3
Constants:
  Mol. Wt. 100.01
  M. P. 196°C
  Density 2.70
Toxicity: See Chromium Compounds.
Caution: This material is usually caustic in its action on skin, mucous membranes or organic matter in general.
MAC: ACGIH (accepted); 0.1 milligrams per cubic meter of air.
Fire Hazard: Dangerous; a very powerful oxidizing agent. In contact with organic matter or reducing agents in general it causes violent reactions (Section 6).
Explosion Hazard: Upon intimate contact with powerful reducing agents it can cause violent explosions.
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Oxidizing material; yellow label.
  Coast Guard Classification: Oxidizing material; yellow label.
  MCA warning label.

CHROMIC ACID SOLUTION. See also Chromic Acid.
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

CHROMIC BROMIDE
Description: Hexagonal olive-green crystals.
Formula: $CrBr_3$
Constants:
Mol. Wt. 291.76
B. P. Sublimes
Density 4.25 @0°C
Toxicity: See Chromium Compounds and Bromides.

CHROMIC CHLORIDE
Description: Crystals.
Formula: $CrCl_3$
Constants:
Mol. Wt. 158.38
B. P. 1300°C (sublimes)
Density 2.76 @15°C
Toxicity: See Chromium Compounds.

CHROMIC FLUORIDE
Description: Rhombic green crystals.
Formula: CrF_3
Constants:
Mol. Wt. 109.01
M. P. > 1000°C
B. P. Sublimes
Density 3.8
Toxicity: See Chromium Compounds and Fluorides.
Disaster Control. See Chromium Compounds and Fluorides.
Storage and Handling: Section 7

CHROMIC NITRATE
Description: Monoclinic brown crystals.
Formula: $Cr(NO_3)_3 \cdot 7\frac{1}{2}H_2O$
Constants:
Mol. Wt. 373.15
M. P. 100°C
Toxicity: See Chromium Compounds and Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

CHROMIC o-PHOSPHATE
Description: Violet crystals.
Formula: $Cr(PO_4) \cdot 2H_2O$
Constants:
Mol. Wt. 183.02
Density 2.42 @32.5°C
Toxicity: See Chromium Compounds.

CHROMIC SESQUISULFIDE
Description: Brown-black powder.
Formula: Cr_2S_3
Constants:
Mol. Wt. 200.02
Density 3.77 @19°C
Toxicity: See Chromium Compounds and Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

CHROMIC SULFATE
Description: Violet or red powder.
Formula: $Cr_2(SO_4)_3$
Constants:
Mol. Wt. 392.22
Density 3.012
Toxicity: See Chromium Compounds.

CHROMIC SULFITE
Description: Greenish-white crystals.
Formula: $Cr_2(SO_3)_3$
Constant: Mol. Wt. 344.22
M. P. Decomp.
Density 2.2
Toxicity: See Chromium Compounds.
Disaster Control: See Sulfites.
Storage and Handling: Section 7

CHROMIUM
Description: Very hard metal; cubic steel-gray crystals.
Formula: Cr
Constants: At. Wt. 52.01
M. P. 1890°C
B. P. 2200°C
Density 7.20
Vap. Press. 1 mm @1616°C
Toxicity: Essentially nontoxic.
Radiation Hazard (Section 5): Artificial isotope Cr^{51}, half-life: 26.5 days; emits gamma rays between 0.26 - 0.32 mev. The permissible levels are: In body: 390 microcuries. In air: 8×10^{-6} microcurie per milliliter. In water: 0.5 microcurie per milliliter.
Fire Hazard: Moderate in form of dust.

CHROMIUM CARBONYL
Description: Colorless crystals.

Formula: $Cr(CO)_6$
Constants:
Mol. Wt. 220.07
M. P. Sublimes at room temp.; sinters at 90°. Decomposes 130°C.
B. P. 151.0°C
Density 1.77
Vap. Press. 1 mm @36.0°C
Vap. D. 7.6
Toxicity: See Chromium Compounds and Carbonyls.
Fire Hazard: See Carbonyls.
Explosion Hazard: See Carbonyls.
Explosive Range: @210°C
Disaster Control: See Carbonyls.
Storage and Handling: Section 7

CHROMIUM CHLORIDE. See Chromic Chloride.

CHROMIUM COMPOUNDS
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: Irritant 3; Ingestion 3; Inhalation 3
Chronic Systemic: Ingestion 3; Inhalation 3
Toxicology: Chromic acid and its salts have a corrosive action on the skin and mucous membranes. The lesions are confined to the exposed parts, affecting chiefly the skin of the hands and forearms and the mucous membranes of the nasal septum. The characteristic lesion is a deep, penetrating ulcer, which, for the most part, does not tend to suppurate, and which is slow in healing.

Small ulcers, about the size of a matchhead or end of a lead pencil may be found, chiefly around the base of the nails, on the knuckles, dorsum of the hands and forearms. These ulcers tend to be clean, and progress slowly. They are frequently painless, even though quite deep. They heal slowly, and leave scars. On the mucous membrane of the nasal septum the ulcers are usually accompanied by purulent discharge and crusting. If exposure continues, perforation of the nasal septum may result, but produces no deformity of the nose. Chromate salts have been associated with cancer of the lungs.
Ventilation Control (use moderate rate): Section 2
Disaster Control: Dangerous; emit highly toxic fumes when heated.
Storage and Handling: Section 7

CHROMIUM FORMATE
Description: Crystals.
Formula: $Cr(CHO_2)_3$
Constant:
Mol. Wt. 187.1
Toxicity: See Chromium Compounds.
Storage and Handling: Section 7

CHROMIUM MONOARSENIDE
Description: Gray hexagonal crystals.
Formula: CrAs
Constants:
Mol. Wt. 126.92
Density 6.35 @16°C
Toxicity: See Arsenic Compounds and Chromium Compounds.
Fire Hazard: See Arsine.
Explosion Hazard: See Arsine.
Disaster Control: Dangerous; when heated to decomposition or on contact with water, steam, acid or acid fumes, it will react to produce toxic and flammable vapors of arsine.
Storage and Handling: Section 7

CHROMIUM MONOBORIDE
Description: Orthorhombic silver crystals.
Formula: CrB
Constants:
Mol. Wt. 62.83
M. P. 2760°C
Density 6.17
Toxicity: See Chromium Compounds and Boron Compounds.
Fire Hazard: See Boron Hydrides.
Explosion Hazard: See Boron Hydrides.
Disaster Control: Dangerous; on contact with water, steam, acid or acid fumes, it will react to produce toxic and flammable vapors or boron hydrides.
Storage and Handling: Section 7

CHROMIUM MONOPHOSPHIDE
Description: Gray-black crystals.

Formula: CrP
Constants:
Mol. Wt. 82.99
Density 5.7 @15°C
Toxicity: See Chromium Compounds and Phosphides.
Fire Hazard: Dangerous; upon contact with moisture, acid or acid fumes, phosphine is evolved. See Phosphine.
Explosion Hazard: See Phosphides and Phosphine.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosphine.
Storage and Handling: Section 7

CHROMIUM OXYCHLORIDE
Synonym: Chromyl chloride.
Description: Dark red liquid; musty burning odor.
Formula: CrO_2Cl_2
Constants:
Mol. Wt. 154.92
M. P. -96.5°C
B. P. 115.7°C
Density 1.9145 @25°/4°C
Vap. Press. 20 mm @20°C
Toxicity: See Chromium Compounds.
Fire Hazard: See Chromic Acid.
Disaster Control: See Chromium Compounds.
Storage and Handling: Section 7

CHROMIUM 2,4-PENTANEDIONE DERIVATIVE
Synonym: Acetylacetonate of chromium.
Description: A solid.
Formula: $Cr(C_5H_7O_2)_3$
Constants:
Mol. Wt. 349.33
M. P. 216°C
B. P. 340°C
Toxicity: See Chromium Compounds.
Disaster Control: See Chromium Compounds.
Storage and Handling: Section 7

CHROMIUM PICRATE
Description: Solid.
Formula: $Cr[C_6H_2OH(NO_2)_3]_3$
Constant:
Mol. Wt. 739.4
Toxicity: See Chromium Compounds and Picrates.
Fire Hazard: See Nitrates.
Explosion Hazard: See Explosives, High and Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

CHROMIUM SULFATE. See Chromic Sulfate.

CHROMIUM TRIOXIDE. See Chromic Acid.

CHROMOUS ACETATE
Description: Red crystals.
Formula: $Cr(C_2H_3O_2)_2$
Constant:
Mol. Wt. 170.10
Toxicity: See Chromium Compounds.

CHROMOUS BROMIDE
Description: White crystals.
Formula: $CrBr_2$
Constants: Mol. Wt. 211.84
M. P. 842°C
Density 4.356
Toxicity: See Chromium Compounds and Bromides.

CHROMOUS CHLORIDE
Description: White deliquescent needles.
Formula: $CrCl_2$
Constants: Mol. Wt. 122.92
M. P. 824°C
Density 2.75
Toxicity: See Chromium Compounds.

CHROMOUS FLUORIDE
Description: Green crystals.
Formula: CrF_2
Constants:
Mol. Wt. 90.01
M. P. 1100°C
B. P. > 1300°C
Density 4.11
Toxicity: See Chromium Compounds and Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

CHROMOUS HYDROXIDE
Description: Yellow-brown crystals.
Formula: $Cr(OH)_2$
Constant:
Mol. Wt. 86.03
Toxicity: See Chromium Compounds.

CHROMOUS IODIDE
Description: Grayish powder.
Formula: CrI_2
Constants:
Mol. Wt. 305.85

Density 5.196
Toxicity: See Chromium Compounds and Iodides.

CHROMOUS MONOSULFIDE
Description: Black powder.
Formula: CrS
Constants:
Mol. Wt. 84.08
Density 4.1
Toxicity: See Chromium Compounds and Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

CHROMOUS MONOXIDE
Description: Black crystals.
Formula: CrO
Constant:
Mol. Wt. 68.01
Toxicity: See Chromium Compounds.

CHROMOUS OXALATE
Description: Yellow crystalline powder.
Formula: $CrC_2O_4 \cdot H_2O$
Constant:
Mol. Wt. 158.05
Toxicity: See Chromium Compounds and Oxalates.

CHROMOUS SULFATE
Description: Blue crystals.
Formula: $CrSO_4 \cdot 7H_2O$
Constant:
Mol. Wt. 274.19
Toxicity: See Chromium Compounds.

CHRYSAROBIN
Synonym: Goa powder.
Description: Brownish to orange-yellow crystals.
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits smoke (Section 6).
Storage and Handling: Section 7

CHRYSOPHANIC ACID
Synonym: 1,8-Dihydroxy-3-methylanthraquinone.
Description: Microcrystalline orange-yellow powder.
Formula:
$C_6H_3(OH)(CO)_2(C_6H_2)(OH)CH_3$
Constants:
Mol. Wt. 254.2
M. P. 196°C
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Personal Hygiene: Section 3

CHRYSOTILE. See Asbestos Particles.

CINERIN I
Synonym: 3-(2-Butenyl)-4-methyl-2-oxo-3-cyclopenten-1-yl ester of chrysanthemum monocarboxylic acid.
Description: Viscous liquid.
Formula: $C_{20}H_{28}O_3$
Constants: Mol. Wt. 316.4
B. P. 200°C @0.1 mm w. decomp.
Toxicity: Details unknown; an insecticide.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

CINERIN II
Synonym: 3-(2-Butenyl)-4-methyl-2-oxo-3-cyclopenten-1-yl ester of chrysanthemum dicarboxylic acid monomethyl ester.
Description: A viscous liquid.
Formula: $C_{21}H_{28}O_5$
Constants:
Mol. Wt. 360.4
B. P. 200°C @0.1 mm
Toxicity: Details unknown; an insecticide.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

CINNABAR. See Mercuric Sulfide.

CINNAMAMIDE
Description: Solid.
Formula: $C_6H_5CHCHCONH_2$
Constants: Mol. Wt. 147.2
M. P. 147°C
Toxicity: Details unknown; an insecticide.
Fire Hazard: Slight; on decomposition, it emits toxic fumes.
Storage and Handling: Section 7

CINNAMIC ACID

Description: White crystalline scales.
Formula: $C_6H_5CHCHCOOH$
Constants:
Mol. Wt. 148.15
M. P. 133°C
B. P. 300°C
Vap. Press. 1 mm @127.5°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

CITRAZINIC ACID

Synonyms: CZA; 2,6-dihydroxy-4-carboxy pyridine.
Description: Buff to grey powder.
Formula: $C_6H_4NO_4$
Constant:
Mol. Wt. 155.12
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: Irritant 1
Chronic Systemic: U
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

CITRIC ACID

Synonym: β-hydroxytricarballylic acid.
Description: Colorless, odorless crystals.
Formula: $C_3H_4(OH)(COOH)_3 \cdot H_2O$
Constants: Mol. Wt. 192.12
M. P. 153°C
B. P. Decomposes
Density 1.542
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: 0
Chronic Local: Allergen 1
Chronic Systemic: 0
Fire Hazard: Slight; when heated, it emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

CITRONELLA

Synonym: Oil of citronella (Ceylon)
Description: Colorless to pale-yellow liquid; turns red on standing; pleasant odor.
Composition: 60% Geraniol; 15% citronellol; 15% camphene and dipentene; also linalool and borneol.
Constant:
Density 0.897 - 0.912
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

CLEANING SOLVENTS (KEROSENE CLASS)

Synonyms: Stoddard solvent; varnolene; varsol, etc.
Description: Clear, volatile liquids, V. M. & P.
Constants:
Flash P. 100°F
Autoign. Temp. 450°F
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 1
Acute Systemic: Ingestion 1; Inhalation 1; Skin Absorption 1
Chronic Local: Irritant 1
Chronic Systemic: Inhalation 1
Fire Hazard: Moderate, when heated, it emits smoke; reacts with oxidizing materials.
Underwriters' Laboratory Classification: 30-40
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 1.1 - 6.0%
Ventilation Control: Section 2
Storage and Handling: Section 7

"CLOROX". See Hypochlorites.

COAL BRIQUETTES, HOT. See also Carbon.
Shipping Regulations: Section 11.
I.C.C. Classification: Not accepted.
Coast Guard Classification: Not permitted.

COAL DUST
Description: Black powder.
Toxic Hazard Rating:
  Acute Local: Inhalation 1
  Acute Systemic: 0
  Chronic Local: Inhalation 2
  Chronic Systemic: Inhalation 2
Fire Hazard: Moderate, when exposed to heat; can react with oxidizing materials (Section 6).
Spontaneous Heating: Moderate
Explosion Hazard: Slight, when exposed to flame.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

COAL GAS
Description: Contains hydrogen, methane, carbon monoxide, etc.
Constants:
  Vap. D. 0.1
  Autoign. Temp. 1200°F
Toxicity: See Carbon Monoxide.
Fire Hazard: Dangerous. See Hydrogen.
To Fight Fire: Carbon dioxide, dry chemical or water spray (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 5.3 - 31%
Ventilation Control (use moderate rate).
Disaster Control: Dangerous. See Hydrogen.
Storage and Handling: Section 7
Shipping Regulations: Section 11
  I. C. C. Classification: Flammable gas; red gas label.

COAL, GROUND BITUMINOUS, SEA COAL, COAL FACINGS, ETC.
Description: Black powder or chunks.
Toxic Hazard Rating:
  Acute Local: Inhalation 1
  Acute Systemic: 0
  Chronic Local: Inhalation 1
  Chronic Systemic: Inhalation 1
MAC: 50 million particles per cubic foot.
Fire Hazard: Moderate, when exposed to heat; can react with oxidizing materials (Section 6).
Spontaneous Heating: Moderate.
Explosion Hazard: Slight, when exposed to flame.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  Coast Guard Classification: Inflammable solid; yellow label.

COALITES. See Explosives, High.

COAL SPECIALS. See Explosives, High.

COAL TAR
Description: Black, viscous liquid.
Composition: Benzene, toluene, naphthalene, anthracene, xylene, phenol, cresol, ammonia, pyridine, thiophene, etc.
Toxic Hazard Rating:
  Acute Local: Irritant 1; Allergen 1; Ingestion 1; Inhalation 1
  Acute Systemic: Inhalation 2
  Chronic Local: Irritant 1; Allergen 1
  Chronic Systemic: Inhalation 3
Fire Hazard: Moderate, when exposed to heat (Section 6).
Explosion Hazard: Moderate, when vapor is exposed to heat or flame.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

COAL TAR DISTILLATE
Toxic Hazard Rating:
  Acute Local: Allergen 1; Ingestion 2; Inhalation 2
  Acute Systemic: Inhalation 2
  Chronic Local: Allergen 2
  Chronic Systemic: Inhalation 3; Skin Absorption 3
Fire Hazard: Dangerous, when exposed to heat or flame; it can react vigorously with oxidizing materials (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.

I.C.C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

COAL TAR DYES

Toxicity: Many of the coal tar dyes are quite harmless and are permitted for foods, drugs and cosmetics. Some of them may be allergens.

COAL TAR LIGHT OIL

Constants:
Density < 1
Flash P. 60 - 77°F
Toxic Hazard Rating:
Acute Local: Allergen 2; Ingestion 1; Inhalation 1
Acute Systemic: Inhalation 1
Chronic Local: Allergen 2
Chronic Systemic: Inhalation 3; Skin Absorption 3
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 1.3 - 8%
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

COAL TAR NAPHTHA. See Naphtha and Coal Tar.

Shipping Regulations: Section 11.
I.C.C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

COAL TAR OIL. See Coal Tar Light Oil.

COAL TAR PITCH

Description: A black to brown tarry mass.
Constant:
Flash P. 405°F (C.C.)
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 2; Inhalation 1
Acute Systemic: U
Chronic Local: Allergen 2
Chronic Systemic: Inhalation 3
Fire Hazard: Slight, when exposed to heat.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

COBALT

Description: Silver-gray metal.
Formula: Co
Constants: At. Wt. 58.9
M. P. 1495°C
B.P. 2900°C
Density 8.9
Toxicity: See Cobalt Compounds.
Radiation Hazard: (Section 5): Artificial isotope Co^{60}, half life: 5.2 years; emits beta particles of 0.31 mev. and gamma rays of 1.2, 1.3 mev. The permissible levels are: In body: 3 microcuries. In air: 10^{-6} microcurie per milliliter. In water: 2×10^{-2} microcuries per milliliter.
Caution: Co^{60} is more likely to be an external hazard than an internal hazard, since the majority of Co^{60} is used as a source of gamma radiation in the form of massive pieces.
Fire Hazard: Moderate, when exposed to heat or flame or by spontaneous chemical reaction. See also Powdered Metals (Section 6).

COBALT ACETATE

Synonym: Cobaltous acetate.
Description: Monoclinic, red-violet, deliquescent crystals.
Formula: $Co(C_2H_3O_2)_2 \cdot 4H_2O$
Constants:
Mol. Wt. 249.09
$-4H_2O$ @140°C

Density 1.705
Toxicity: See Cobalt Compounds.

COBALT ALUMINATE

Description: Cubic blue cyrstals.
Formula: $CoAl_2O_4$
Constant:
Mol. Wt. 176.88
Toxicity: See Cobalt Compounds and Aluminum Compounds.

COBALT ARSENIC SULFIDE

Synonym: Cobaltite.
Description: Gray-reddish crystals.
Formula: CoAsS
Constants:
Mol. Wt. 165.92
M. P. Decomposes
Density 6.2 - 6.3
Toxicity: See Arsenic Compounds and Sulfides.
Fire Hazard: See Sulfides and Arsine.
Explosion Hazard: See Sulfides and Arsine.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes or arsine and oxides of sulfur; it will react with water, steam, acid or acid fumes to produce toxic and flammable vapors of arsine and hydrogen sulfide.
Storage and Handling: Section 7

COBALT BROMOPLATINATE

Description: Crystals.
Formula: $CoPtBr_6 \cdot 12H_2O$
Constants:
Mol. Wt. 949.86
Density 2.762
Toxicity: See Cobalt Compounds, Bromides and Platinum Compounds.
Disaster Control: Dangerous on decomposition, it emits toxic fumes.
Storage and Handling: Section 7

COBALT CARBONYL

Synonyms: Cobalt tricarbonyl; tetracobalt dodecacarbonyl.
Description: Black crystals.
Formula: $(Co(CO)_3)_4$ or $Co_4(CO)_{12}$
Constant:
Mol. Wt. 571.88
Toxicity: See Carbon Monoxide, Carbonyls and Cobalt Compounds.
Fire Hazard: See Carbonyls and Carbon Monoxide.
Explosion Hazard: See Carbonyls and Carbon Monoxide.
Disaster Control: Dangerous; when heated to decomposition, or on contact with water or steam, it will react to produce toxic and flammable vapors of carbon monoxide.
Storage and Handling: Section 7

COBALT CHLORIDE

Description: Blue powder.
Formula: $CoCl_2$
Constants: Mol. Wt. 129.86
M. P. Sublimes
B. P. 1049°C
Density 3.348
Toxicity: See Cobalt Compounds.

COBALT CHLOROPLATINATE

Description: Crystals.
Formula: $CoPtCl_6 \cdot 6H_2O$
Constants:
Mol. Wt. 575.01
M. P. Decomposes
Density 2.699
Toxicity: See Cobalt Compounds and Platinum Compounds.

COBALT CHLOROSTANNATE

Description: Rhombic or trigonal crystals.
Formula: $CoSnCl_6 \cdot 6H_2O$
Constants:
Mol. Wt. 498.48
M. P. Decomposes 100°C
Toxicity: See Cobalt Compounds and Tin Compounds.

COBALT COMPOUNDS

Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: Ingestion 1; Inhalation 1
Chronic Local: Irritant 1; Allergen 1
Chronic Systemic: Ingestion 1 Inhalation 1
Toxicology: Experimental evidence shows that the toxicity of cobalt by mouth is low. In animals, administration of cobalt salts produces polycythemia. In humans, a single case of poisoning liver and kidney damage has been attributed to cobalt. Locally, cobalt has been shown to produce dermatitis and certain investigators have been able to demonstrate

a hypersensitivity of the skin to cobalt (Section 9).
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3

COBALTIC ACETATE
Description: Green crystals.
Formula: $Co(C_2H_3O_2)_3$
Constant:
Mol. Wt. 236.07
Toxicity: See Cobalt Compounds.

COBALTIC CHLORIDE
Description: Red crystals.
Formula: $CoCl_3$
Constants:
Mol. Wt. 165.31
M. P. Sublimes
Density 2.94
Toxicity: See Cobalt Compounds.

COBALTIC FLUORIDE
Description: Hexagonal brown crystals.
Formula: CoF_3
Constants:
Mol. Wt. 115.94
Density 3.88
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

COBALTIC HYDROXIDE
Description: Black-brown powder.
Formula: $Co(OH)_3$
Constants:
Mol. Wt. 109.96
M. P. Decomposes $-1\frac{1}{2}H_2O$ @100°C
Toxicity: See Cobalt Compounds.

COBALTIC OXIDE
Description: Black-gray powder.
Formula: Co_2O_3
Constants:
Mol. Wt. 165.88
M. P. Decomposes 895°C
Density 5.18
Toxicity: See Cobalt Compounds.

COBALTIC SESQUISULFIDE
Description: Black crystals.
Formula: Co_2S_3
Constants:
Mol. Wt. 214.08
Density 4.8
Toxicity: See Sulfides and Cobalt Compounds.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: Dangerous; when heated to decomposition, or on contact with acid or acid fumes, it can emit highly toxic fumes of hydrogen sulfide.
Storage and Handling: Section 7

COBALTIC SULFATE
Description: Blue needles.
Formula: $Co_2(SO_4)_3 \cdot 18H_2O$
Constant:
Mol. Wt. 730.37
Toxicity: See Cobalt Compounds.

COBALT IODOPLATINATE
Description: Crystals.
Formula: $CoPtI_6 \cdot 9H_2O$
Constants:
Mol. Wt. 1177.83
Density 3.618
Toxicity: See Cobalt Compounds, Iodides and Platinum Compounds.

COBALT MONOBORIDE
Description: Prisms.
Formula: CoB
Constants:
Mol. Wt. 69.76
Density 7.25 @18°C
Toxicity: See Cobalt Compounds and Boron Compounds.
Fire Hazard: See Boron Hydrides.
Explosion Hazard: See Boron Hydrides.
Disaster Control: Dangerous; it will react with water, steam, acid or acid fumes to produce toxic and flammable vapors of boron hydrides.
Storage and Handling: Section 7

COBALT MONOSELENIDE
Description: Yellow crystals.
Formula: CoSe
Constants:
Mol. Wt. 137.90
M. P. Red heat.
Density 7.65
Toxicity: See Selenium and Cobalt Compounds.
Fire Hazard: See Hydrogen Selenide.
Explosion Hazard: See Hydrogen Selenide.
Disaster Control: Dangerous; when heated or on contact with water, steam, acid or acid fumes, it will react to produce highly toxic and flammable vapors of hydrogen

selenide.
Storage and Handling: Section 7

COBALT MONOSULFIDE
Description: Reddish, silver-white crystals.
Formula: CoS
Constants:
  Mol. Wt. 91.01
  M. P. > 1116°C
  Density 5.45
Toxicity: See Sulfides and Cobalt Compounds.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it can emit highly toxic fumes of sulfur compounds.
Storage and Handling: Section 7

COBALTOUS o-ARSENATE
Synonym: Erythrite.
Description: Monoclinic violet-red crystals.
Formula: $Co_3(AsO_4)_2 \cdot 8H_2O$
Constants:
  Mol. Wt. 598.77
  M. P. Decomposes
  Density 2.948
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

COBALTOUS BENZOATE
Description: Gray-red leaf.
Formula: $Co(C_7H_5O_2)_2 \cdot 4H_2O$
Constants:
  Mol. Wt. 373.22
  M. P. $-4H_2O$ @115°C
Toxicity: See Cobalt Compounds.
Fire Hazard: Slight, when exposed to heat (Section 6).
Storage and Handling: Section 7

COBALTOUS BROMATE
Description: Red crystals.
Formula: $Co(BrO_3)_2 \cdot 6H_2O$
Constant:
  Mol. Wt. 422.87
Toxicity: See Cobalt Compounds and Bromates.
Fire Hazard: See Bromates.
Disaster Control: See Bromates.
Storage and Handling: Section 7

COBALTOUS BROMIDE
Description: Green deliquescent crystals.
Formula: $CoBr_2$
Constants:
  Mol. Wt. 218.77
  M. P. Decomposes
  Density 4.909 @25°C
Toxicity: See Cobalt Compounds and Bromides.

COBALTOUS CARBONATE
Synonym: Spherocobaltite.
Description: Red crystals.
Formula: $CoCO_3$
Constants:
  Mol. Wt. 118.95
  M. P. Decomposes
  Density 4.13
Toxicity: See Cobalt Compounds.

COBALTOUS CHLORATE
Description: Cubic, red, deliquescent crystals.
Formula: $Co(ClO_3)_2 \cdot 6H_2O$
Constants:
  Mol. Wt. 333.95
  M. P. 61°C
  B. P. Decomposes @100°C
  Density 1.92
Toxicity: See Cobalt Compounds and Chlorates.
Fire Hazard: See Chlorates.
Caution: Can explode easily when contaminated.
Explosion Hazard: See Chlorates.
Disaster Control: See Chlorates.
Storage and Handling: Section 7

COBALTOUS CHLORIDE
Description: Black crystals.
Formula: $CoCl_2$
Constants:
  Mol. Wt. 129.85
  M. P. 735°C
  B. P. 1050°C
  Density 3.356
  Vap. Press. 40 mm @770°C
Toxicity: See Cobalt Compounds.

COBALTOUS CHROMATE
Description: Gray-black crystals.
Formula: $CoCrO_4$
Constants:
  Mol. Wt. 174.95
  M. P. Decomposes
Toxicity: See Chromium Compounds and Cobalt Compounds.
Storage and Handling: Section 7

COBALTOUS CITRATE
Description: Rose-red crystals.
Formula: $Co_3(C_6H_5O_7)_2 \cdot 2H_2O$
Constants:
  Mol. Wt. 591.05
  M. P. $-2H_2O$ @ 150°C
Toxicity: See Cobalt Compounds.

COBALTOUS CYANIDE
Description: Buff color; anhydrous, a blue violet powder.
Formula: $Co(CN)_2 \cdot 2H_2O$
Constants:
  Mol. Wt. 147.01
  M. P. $-2H_2O$ @280°C
  Density Anhydrous 1.872 @25°C
Toxicity: See Cyanides.
Fire Hazard: See Cyanides.
Explosion Hazard: See Cyanides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid, acid fumes, water or steam, it will react to produce highly toxic fumes of hydrogen cyanide.
Storage and Handling: Section 7

COBALTOUS FERRICYANIDE
Description: Red needles.
Formula: $Co_3(Fe(CN)_6)_2$
Constant:
  Mol. Wt. 600.74
Toxicity: See Ferricyanides and Cobalt Compounds.
Disaster Control: See Ferricyanides.
Storage and Handling: Section 7

COBALTOUS FERROCYANIDE
Description: Gray-green crystals.
Formula: $Co_2Fe(CN)_6 \cdot {}_xH_2O$
Toxicity: See Ferrocyanides and Cobalt Compounds.
Disaster Control: See Ferrocyanides.
Storage and Handling: Section 7

COBALTOUS FLUOGALLATE
Description: Pink crystals.
Formula: $[Co(H_2O)_6](GaF_5H_2O)$
Constants:
  Mol. Wt. 349.8
  M. P. $-5H_2O$ @110°C
  Density 2.35
Toxicity: See Fluogallates and Cobalt Compounds.
Disaster Control: See Fluogallates.
Storage and Handling: Section 7

COBALTOUS FLUORIDE
Description: Monoclinic, rose-red crystals.
Formula: $CoF_2 \cdot 2H_2O$
Constants:
  Mol. Wt. 132.97
  Density 4.46
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

COBALTOUS FLUOSILICATE
Description: Pink crystals.
Formula: $CoSiF_6 \cdot 6H_2O$
Constants:
  Mol. Wt. 309.10
  Density 2.113 @19°C
Toxicity: See Fluosilicates.
Disaster Control: See Fluosilicates.
Storage and Handling: Section 7

COBALTOUS FORMATE
Description: Red crystals.
Formula: $Co(CHO_2)_2 \cdot 2H_2O$
Constants: Mol. Wt. 185.01
  M. P. $-2H_2O$ @140°C
  B. P. Anhydrous decomposes 175°C
  Density 2.129 @22°C
Toxicity: See Cobalt Compounds.

COBALTOUS HYDROXIDE
Description: Rhombic rose-red crystals.
Formula: $Co(OH)_2$
Constants:
  Mol. Wt. 92.96
  M. P. Decomposes
  Density 3.597 @15°C
Toxicity: See Cobalt Compounds.

COBALTOUS IODATE
Description: Balck-violet needles.
Formula: $Co(IO_3)_2$
Constants:
  Mol. Wt. 408.78
  Density 5.008 @18°C
Toxicity: See Cobalt Compounds and Iodates.
Fire Hazard: See Iodates.
Disaster Control: See Iodates.
Storage and Handling: Section 7

alpha-COBALTOUS IODIDE
Description: Hexagonal black crystals.
Formula: CoI_2

Constants:
Mol. Wt. 312.78
Density 5.68
Toxicity: See Cobalt Compounds and Iodides.

COBALTOUS LINOLEATE
Description: Brown amorphous mass.
Formula: $Co(C_{18}H_{31}O_2)_2$
Constant:
Mol. Wt. 617.80
Toxicity: See Cobalt Compounds.
Fire Hazard: Slight, when exposed to heat (Section 6).
Storage and Handling: Section 7

COBALTOUS NITRATE
Description: Red crystals.
Formula: $Co(NO_3)_2 \cdot 6H_2O$
Constants:
Mol. Wt. 291.05
M. P. < 100°C
$-3H_2O$ @ 55°C
Density 1.87
Toxicity: See Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

COBALTOUS OLEATE
Description: Brown amorphous powder.
Formula: $Co(C_{18}H_{33}O_2)_2$
Constant:
Mol. Wt. 621.83
Toxicity: See Cobalt Compounds.
Fire Hazard: Slight, when exposed to heat (Section 6).
Storage and Handling: Section 7

COBALTOUS OXALATE
Description: Reddish white crystals.
Formula: CoC_2O_4
Constants:
Mol. Wt. 146.96
Density 3.021 @25°C
Toxicity: See Oxalates.

COBALTOUS OXIDE
Description: Cubic green-brown crystals.
Formula: CoO
Constants:
Mol. Wt. 74.94
M. P. 1800°C Decomposes
Density 5.7 - 6.7
Toxicity: See Cobalt Compounds.

COBALTOUS PERCHLORATE
Description: Red needles.
Formula: $Co(ClO_4)_2$
Constants:
Mol. Wt. 257.85
Density 3.327
Toxicity: See Perchlorates.
Fire Hazard: See Perchlorates.
Explosion Hazard: See Perchlorates.
Disaster Control: See Perchlorates.
Storage and Handling: Section 7

COBALTOUS PERRHENATE
Description: Dark pink crystals.
Formula: $Co(ReO_4)_2 \cdot 5H_2O$
Constants:
Mol. Wt. 649.64
M. P. Decomposes
Toxicity: See Cobalt Compounds and Rhenium Compounds.
Fire Hazard: Dangerous. An oxidizing agent.
Disaster Control: Dangerous. Keep away from combustible materials.
Storage and Handling: Section 7

COBALTOUS o-PHOSPHATE
Description: Reddish crystals.
Formula: $Co_3(PO_4)_2$
Constant:
Mol. Wt. 366.78
Toxicity: See Cobalt Compounds.

COBALTOUS PROPIONATE
Description: Dark red crystals.
Formula: $Co(C_3H_5O_2)_2 \cdot 3H_2O$
Constants:
Mol. Wt. 259.13
M. P. Ca. 250°C
Toxicity: See Cobalt Compounds.
Fire Hazard: Slight, when exposed to heat (Section 6).
Storage and Handling: Section 7

COBALTOUS RESINATE
Description: Brown-red powder.
Formula: $Co(C_{44}H_{62}O_4)_2$
Constant:
Mol. Wt. 1368.81
Toxicity: See Cobalt Compounds.
Fire Hazard: Dangerous; spontaneously flammable in air; reacts vigorously with oxidizing materials (Section 6).
Storage and Handling: Section 7

COBALTOUS SELENATE
Description: Ruby-red crystals.

Formula: $CoSeO_4 \cdot 5H_2O$
Constants:
Mol. Wt. 291.98
M. P. Decomposes
Density 2.512
Toxicity: See Selenium Compounds and Cobalt Compounds.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

COBALTOUS ortho-SILICATE

Description: Violet crystals.
Formula: Co_2SiO_4
Constants:
Mol. Wt. 209.94
Density 4.63
Toxicity: See Cobalt Compounds and Silicates.

COBALTOUS SULFATE

Description: Red, water-soluble powder.
Formula: $CoSO_4$
Constants:
Mol. Wt. 155
M. P. 989°C
Density 3.71 @25°/25°C
Toxicity: See Cobalt Compounds.

COBALTOUS SULFITE

Description: Red crystals.
Formula: $CoSO_3 \cdot 5H_2O$
Constant:
Mol. Wt. 229.08
Toxicity: See Cobalt Compounds and Sulfites.
Disaster Control: See Sulfites.
Storage and Handling: Section 7

COBALTOUS TARTRATE

Description: Monoclinic reddish crystals.
Formula: $CoC_4H_4O_6$
Constant:
Mol. Wt. 207.01
Toxicity: See Cobalt Compounds.

COBALTOUS THIOCYANATE

Description: Rhombic violet crystals.
Formula: $Co(SCN)_2 \cdot 3H_2O$
Constants:
Mol. Wt. 229.16
M. P. $-3H_2O$ @ 105°C
Toxicity: See Thiocyanates.
Disaster Control: See Thiocyanates.
Storage and Handling: Section 7

COBALTOUS TUNGSTATE

Description: Monoclinic blue-green crystals.
Formula: $CoWO_4$
Constants:
Mol. Wt. 306.86
Density 8.42
Toxicity: See Cobalt Compounds and Tungsten Compounds.

COBALT OXIDE

Description: Brown or black powder.
Formula: CoO
Constants: Mol. Wt. 74.94
M. P. 1800°C
Density 5.6 - 5.75
Toxicity: See Cobalt Compounds.

COBALT PALMITATE

Description: A solid.
Formula: $Co(C_{16}H_{31}O_2)_2$
Constants:
Mol. Wt. 569.76
M. P. 70.5°C
Toxicity: See Cobalt Compounds.
Fire Hazard: Slight, when heated, it emits acrid fumes.
Storage and Handling: Section 7

COBALT PHOSPHIDE

Description: Small gray needles.
Formula: Co_2P
Constant: Mol. Wt. 148.9
M. P. 138.6°C
Toxicity: See Phosphides.
Fire Hazard: Dangerous; it decomposes to evolve phosphine (Section 6).
Explosion Hazard: See Phosphides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid, acid fumes, water or steam, it will react to produce highly toxic and flammable vapors of phosphine.
Storage and Handling: Section 7

COBALT RESINATE, PRECIPITATED

Toxicity: See Cobalt Compounds.
Fire Hazard: Dangerous; spontaneously flammable in air; reacts with oxidizing materials (Section 6).
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

COBALT TETRACARBONYL

Synonym: Dicobaltoctacarbonyl.
Description: Orange crystals or dark brown microcrystals.
Formula: $Co_2(CO)_8$
Constants:
  Mol. Wt. 342.0
  M. P. 51°C
  B. P. Decomposes 52°C
  Density 1.73 @18°C
Toxicity: See Carbonyls.
Fire Hazard: See Carbonyls and Carbon Monoxide.
Explosion Hazard: See Carbonyls and Carbon Monoxide.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of carbon monoxide; it can react with oxidizing materials.
Storage and Handling: Section 7

COBALT o-TITANATE

Description: Cubic greenish-black crystals.
Formula: Co_2TiO_4
Constants:
  Mol. Wt. 229.78
  Density 5.07 - 5.12
Toxicity: See Cobalt Compounds.

COCAINE

Synonym: Methyl benzoylecgonine.
Description: Colorless to white crystals.
Formula: $C_{17}H_{21}NO_4$
Constants:
  Mol. Wt. 303.35
  M. P. 98°C
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: Allergen 1
  Chronic Systemic: Ingestion 3; Inhalation 3
Toxicology: A poisonous and habit-forming alkaloid. It can cause dilation and immobility of the pupils, blepharitis and blindness. Fatal cases run a very rapid course with anxiety, sudden fainting, extreme pallor, dyspnea, sometimes brief convulsions, arrest of respiration and death, generally in a few minutes. If death does not occur in a few minutes to a half hour, the patient almost always recovers.
Treatment and Antidotes:
  Wash stomach out immediately with water and sodium bicarbonate (60 grains to 1 pint). If a solution of permanganate is handy (1 crystal to 8 oz. of water), use it to wash out stomach. Give inhalations of ammonia. Allay convulsions with chloral or chloroform. If breathing is disturbed, give artificial respiration and cardiac massage after respiration fails. Inhalations of oxygen plus 5% carbon dioxide should be given.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

COCCULUS SOLID

Synonym: Fish berry.
Description: Dried ripe fruit of a woody climbing plant.
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3
  Chronic Local: U
  Chronic Systemic: U
Caution: Contains picrotoxin, a convulsant poison.
Fire Hazard: Slight, when exposed to heat (Section 6).
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.

COCOA

Description: Brown powder.
Toxic Hazard Rating:
  Acute Local: Allergen 2
  Acute Systemic: Ingestion 1; Inhalation 1
  Chronic Local: Allergen 1
  Chronic Systemic: Ingestion 1; Inhalation 1
Fire Hazard: Slight; when heated, it emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

COCOA BEAN SHELL TANKAGE

Description: A hygroscopic material.
Toxicity: See Cocoa.
Fire Hazard: Moderate, when exposed to heat.
Spontaneous Heating: Moderate. Extreme caution must be observed to keep the moisture content low; on contact with oxidizing materials, it can react vigorously.
Storage and Handling: Section 7

COCO BOLO

Description: A wood.
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: 0
  Chronic Local: Allergen 1
  Chronic Systemic: 0
Fire Hazard: Slight; when exposed to heat or flame (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

CODEINE

Synonym: Methylmorpholine.
Formula: $C_{18}H_{21}NO_3 \cdot H_2O$
Constants: Mol. Wt. 317.37
  M. P. 154.9°C
Toxic Hazard Rating:
  Acute Local: 0
  Acute Systemic: 3
  Chronic Local: 0
  Chronic Systemic: 3
Shipping Regulations: Subject to Federal narcotic restrictions.

COFFEE

Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: Ingestion 1
  Chronic Local: Allergen 1
  Chronic Systemic: Ingestion 1
Remarks: Coffee tasters can have amblyopia and coffee has been known to cause temporary blindness.
Disaster Control: Slightly dangerous in dry state; when heated, it burns and emits acrid fumes.
Storage and Handling: Section 7

COKE, HOT

Description: A black amorphous mass.
Composition: Carbon and impurities.
Toxicity: See Carbon and Charcoal.
Fire Hazard: See Carbon.
Caution: While still hot it may ignite easily in air or by contact with spark or flame.
Disaster Control: See Carbon and Charcoal.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Not accepted.
  Coast Guard Classification: Not permitted.

COLCHICINE

Description: Yellow, crystalline alkaloid, amorphous powder.
Formula: $C_{22}H_{25}NO_6$
Constants:
  Mol. Wt. 399.43
  M. P. Anhyd. 143.7°C
Toxic Hazard Rating:
  Acute Local: Irritant 2; Inhalation 2
  Acute Systemic: Ingestion 3
  Chronic Local: U
  Chronic Systemic: Ingestion 3
Toxicology: A poisonous alkaloid. No symptoms result from small doses. Large doses cause diarrhea with griping in susceptible persons. Symptoms take several hours and arise from the alimentary tract. Pain in the gastric region is followed by salivation, nausea, vomiting and diarrhea. Depression, apathy and collapse follow. In experimental poisoning, paralysis starts with the posterior limbs and increases upward until the forelimbs and respiratory muscles are involved and death occurs from asphyxia. Externally, it is a local irritant, which causes redness and smarting when applied to the skin. Upon inhalation, the dust causes sneezing and conjunctival hyperemia and a burning sensation of mouth and throat. 0.02 gram is very likely to cause death in about 24 hours from a single dose. Repeated doses may be cumulative.
Treatment and Antidotes: Give a cathartic and an emetic at once, also large quantities of water for the kidneys. Tannic acid should be given in large amounts. Opium and stimulants should also be given to counteract depression.
Fire Hazard: Slight; on decomposition it emits toxic fumes (Section 6).
Ventilation Control (use normal rate):

Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

COLCHICINE TANNATE. See Colchicine.

COLLIERS. See Explosives, High.

COLLODION COTTON. See Nitrocellulose.

COLLODION WOOL. See Nitrocellulose.

COLOCYNTH
Synonyms: Bitter apple; bitter cucumber.
Description: Dried pulp.
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes.
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

COLOGNE SPIRITS (ALCOHOL) See Ethyl Alcohol.
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

"COLONIAL SPIRITS". See Methyl Alcohol.

COLOPHONY, POWDER
Synonym: Rosin.
Description: Pale yellow to amber, translucent fragments, turpentine odor and taste.
Constant:
Density 1.07 - 1.09
Toxicity: An allergen. See also Abietic Acid.
Fire Hazard: Moderate; when exposed to flame or by chemical reaction; it can react with oxidizing materials (Section 6).
Spontaneous Heating: Very high. May ignite spontaneously in air.
Storage and Handling: Section 7

COLUMBIAN SPIRITS. See Methyl Alcohol.
Shipping Regulations: Section 11.
Coast Guard Classification: Inflammable liquid; red label.

COLUMBIUM. See Niobium.

COLUMBIUM CHLORIDE
Synonym: Columbium pentachloride.
Description: Yellow-white, deliquescent powder.
Formula: $CbCl_5$
Constants:
Mol. Wt. 270.20
M. P. 194°C
B. P. 240.5°C
Toxicity: See Hydrochloric Acid.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes of hydrochloric acid.

COMBINATION FUZES. See Explosives, High.
Shipping Regulations: Section 11.
I.C.C. Classification: Explosive C.
Coast Guard Classification: Explosive C.

COMBINATION PRIMERS. See Explosives, High.
Shipping Regulations: Section 11.
I.C.C. Classification: Explosive C.
Coast Guard Classification: Explosive C.

COMPRESSED GASES (FLAMMABLE) See specific gas.
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable gas; red gas label.
Coast Guard Classification: Inflammable gas; red gas label.

COMPRESSED GASES, N.O.S. See specific gas.
Shipping Regulations: Section 11.
I.C.C. Classification: Nonflammable gas; green label.
Coast Guard Classification: Noninflammable gas; green gas label.

CONDURANGIN
Description: Yellowish, amorphous, bitter powder.

Formula: $C_{35}H_{54}O_{14}(OCH_3)_2$
Constants:
Mol. Wt. 760.9
Toxic Hazard Rating:
Acute Local: Ingestion 1
Acute Systemic: Ingestion 1
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

CONHYDRINE

Description: Colorless, crystalline alkaloid.
Formula: $C_8H_{17}NO$
Constants:
Mol. Wt. 143.23
M. P. 121°C
B. P. 226°C
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Toxicology: Poisonous alkaloid. Toxic doses cause weakness and drowsiness but not actual sleep. Movements are weak and unsteady and gait is staggering. There are usually nausea and vomiting with profuse salivation. Intelligence usually remains clear. The pupils are ordinarily somewhat dilated and ptosis also occurs, indicating oculomotor paralysis. Speech is thick and hearing is imperfect. Tremors and occasional convulsions occur. Breathing becomes weaker and slower and finally stops, causing death. It is said to have a depressant effect on bruised surfaces of the skin. One-half to one grain is considered a poisonous dose.
Treatment and Antidotes: Administer emetics and wash stomach out. Then give tannic acid freely and wash stomach out again. Strychnine and other stimulants are given hyperdermically. Keep patient warm and administer artificial respiration. A physician should be summoned.
Fire Hazard: Slight; when heated, it emits toxic fumes.
Ventilation Control (use normal rate): Section 2.
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

CONIINE

Synonyms: Cicutine; cicuta; conicine.
Description: Colorless, oily liquid with mousy odor.
Formula: $C_8H_{17}N$
Constants:
Mol. Wt. 127.23
B. P. 166.5°C
Freezing P. −2.5°C
Density 0.844 - 0.848 @20°/4°C
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Toxicology: Produces paralysis of the nervous system. In small doses it is a sedative. Poisoning is treated by evacuating the stomach and administering tannic acid.
Fire Hazard: Slight; when heated, it emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

CONIINE HYDROCHLORIDE. See Coniine.

CONIUM. See Coniine.

CONIUM MACULATIUM. See Coniine.

CONTAINERS, EMPTY. See Acid Carboys, Empty; Bottles, Empty; Drums, Empty; Cylinders, Empty.

COPAL

Synonyms: Resin copal; gum copal.
Description: Yellowish-brown pieces.
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes.

Personal Hygiene: Section 3
Storage and Handling: Section 7

COPPER

Description: Distinct reddish color.
Formula: Cu
Constants:
At. Wt. 63.54
M. P. 1083°C
B. P. 2324°C
Density 8.92
Vap. Press. 1 mm @1628°C
Toxicity: See Copper Compounds.
Radiation Hazard (Section 5): Artificial isotope Cu^{64}, half-life: 12.8 hours; emits gamma rays between 1-3 mev; positron particles of 0.66 mev and electron particles of 0.57 mev. The permissible levels are: In body: 150 microcuries. In air: 6×10^{-6} microcurie per milliliter. In water: 8×10^{-2} microcurie per milliliter. Hazard Rating, Class I (National Bureau of Standards Handbook No. 42).
Fire Hazard: See Powdered Metals.

COPPER ABIETINATE

Synonym: Cupric abietinate.
Description: Green scales.
Formula: $Cu(C_{19}H_{27}O_2)_2$
Constant:
Mol. Wt. 637.69
Toxicity: See Copper Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

COPPER ACETATE

Synonyms: Cupric acetate; neutral verdigris.
Description: Greenish-blue, fine powder or small crystals.
Formula: $Cu(C_2H_3O_2)_2 \cdot H_2O$
Constants:
Mol. Wt. 199.64
M. P. 115°C
B. P. 240°C Decomposes
Density 1.882; (anhydrous) 1.93
Toxicity: See Copper Compounds.

COPPER ACETATE, BASIC

Synonym: Verdigris.
Description: Greenish-blue powder.
Formula: $Cu(C_2H_3O_2)_2 \cdot CuO \cdot 6H_2O$
Constant:
Mol. Wt. 369.33
Toxicity: See Copper Compounds.

COPPER ACETOARSENITE

Synonyms: Emerald green; imperial; kings green; moss green; Vienna green.
Description: Emerald green powder.
Formula: $(CuO)_3As_2O_3 \cdot Cu(C_2H_3O_2)_2$
Constant:
Mol. Wt. 618.15
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

COPPER ACETONATE

Toxicity: See Copper Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

COPPER ACETYLIDE. See Cuprous Acetylide.

COPPER AMMONIUM SULFATE

Description: Crystals.
Formula: $CuSO_4 \cdot 4NH_3 \cdot H_2O$
Constant:
Mol. Wt. 245.8
Toxicity: See Copper Compounds.

COPPER ARSENATE, BASIC

Synonym: Cuprous arsenate, basic.
Description: A green solid.
Formula: $Cu(CuOH)AsO_4$
Constant:
Mol. Wt. 283.0
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

COPPER ARSENIDE

Description: Black crystals.
Formula: Cu_5As_2
Constants: Mol. Wt. 467.52
M. P. Decomposes
Density 7.56
Toxicity: See Arsenic Compounds.
Fire Hazard: See Arsine.
Explosion Hazard: See Arsine.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it can emit toxic fumes of arsine.
Storage and Handling: Section 7

COPPER ARSENITE
Synonyms: Cupric arsenite; Sheele's mineral.
Description: Yellowish-green powder.
Formula: $CuHAsO_3$
Constants: Mol. Wt. 187.5
M. P. Decomp.
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

COPPER BORIDE
Synonym: Cupric boride.
Description: Yellow crystals.
Formula: Cu_3B_2
Constants:
Mol. Wt. 212.26
Density 8.116
Toxicity: See Copper Compounds and Boron Compounds.
Fire Hazard: See Boron Hydrides.
Explosion Hazard: See Boron Hydrides.
Disaster Control: Moderately dangerous; on contact with acid, acid fumes, water or steam, it will react to produce toxic and flammable vapors of boron hydrides.
Storage and Handling: Section 7

COPPER CARBONATE
Synonym: Cupric carbonate.
Description: Green powder.
Formula: $CuCO_3 \cdot Cu(OH)_2$
Constants:
Mol. Wt. 221.17
M. P. Decomposes 200°C
Density 4.0
Toxicity: See Copper Compounds.

COPPER CHLORATE. See Cupric Chlorate.

COPPER CHLORIDE
Synonym: Cupric chloride.
Description: Yellowish-brown, hygroscopic powder.
Formula: $CuCl_2$
Constants:
Mol. Wt. 134.48
M. P. 498°C
Density 3.054
Toxicity: See Copper Compounds.

COPPER gamma-CHLOROACETOACETANILIDE
Description: Solid.
Formula: $Cu(C_8H_7ClNO)_2$
Constant:
Mol. Wt. 400.7
Toxicity: See Copper Compounds and Acetanilide.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

COPPER CHROMATE, BASIC. See Cupric Chromate, Basic.

COPPER COMPOUNDS
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1; Ingestion 1; Inhalation 1
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: Allergen 1
Chronic Systemic: Ingestion 1; Inhalation 1

Toxicology: As the sublimed oxide, copper may be responsible for one form of metal fume fever. Inhalation of copper dust has caused, in animals, hemolysis of the red blood cells, deposition of hemofuscin in the liver and pancreas, and injury to the lung cells; injection of the dust has caused cirrhosis of the liver and pancreas, and a condition closely resembling herochromatosis, or bronzed diabetes. However, considerable trial exposure to copper compounds has not resulted in such disease.

As regards local effect, copper chloride and sulfate have been reported as causing irritation of the skin and conjunctivae which may be on an allergic basis (Section 9). Cuprous oxide is irritating to the eyes and upper respiratory tract. Discoloration of the skin is often seen in persons handling copper, but this does not indicate any actual injury from copper.

"In man the ingestion of a large quantity of copper sulfate has caused vomiting, gastric pain, dizziness, exhaustion, anemia, cramps, convulsions, shock, coma and death. Symptoms attributed to damage to the nervous system and kidney have been recorded, jaundice has been observed and, in some cases, the liver has been enlarged. Deaths have been reported to have occured following the ingestion of so little as 27 grams of the salt, while other victims have recovered after having taken much larger amounts, up to 120 grams." "Copper: the Metal, its Alloys and Compounds", ed. Alison Butts, p. 857, Reinhold, 1954.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Shipping Regulations: (10 % and over as Metallic Copper): Section 11 MCA warning label.

COPPER-8-CUNILATE

Toxicity: See Copper Compounds.

Fire Hazard: Slight; when heated, it emits acrid fumes.

Storage and Handling: Section 7

COPPER CYANIDE

Synonym: Cupric cyanide.

Description: Yellowish-green powder.

Formula: $Cu(CN)_2$

Constants: Mol. Wt. 115.61
M. P. Decomposes before melting.

Toxicity: See Cyanides.

Fire Hazard: See Cyanides.

Explosion Hazard: See Cyanides.

Disaster Control: Dangerous; when heated to decomposition or on contact with acid, acid fumes, water or steam, it will react to produce toxic and flammable vapors of hydrogen cyanide.

Storage and Handling: Section 7

Shipping Regulations: Section 11.
Coast Guard Classification: No restrictions.

COPPER DIMETHYLDITHIOCARBAMATE

Toxicity: See Copper Compounds.

Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.

Storage and Handling: Section 7

COPPER FLUORIDE

Synonym: Cupric fluoride.

Description: Monoclinic blue crystals.

Formula: $CuF_2 \cdot 2H_2O$

Constants: Mol. Wt. 137.60
Density 2.93

Toxicity: See Fluorides and Copper Compounds.

Disaster Control: See Fluorides.

Storage and Handling: Section 7

COPPER HYDRIDE

Description: Red-brown crystals.

Formula: CuH

Constants: Mol. Wt. 64.55
M. P. Decomposes 60°C

Toxicity: See Copper Compounds and Hydrides.

Fire Hazard: See Hydrides.

Explosion Hazard: See Hydrides.

Disaster Control: See Hydrides.

COPPER HYDROSELENITE

Description: Bluish-green, tiny prisms.

Formula: $Cu(HSeO_3)_2$

Constant: Mol. Wt. 319.5

Toxicity: See Selenium Compounds and Copper Compounds.

Disaster Control: See Selenium Compounds.

Storage and Handling: Section 7

COPPER HYDROXIDE

Synonym: Cupric hydroxide.

Description: Blue gelatinous or amorphous powder.

Formula: $Cu(OH)_2$

Constants: Mol. Wt. 97.59
Density 3.368

Toxicity: See Copper Compounds.

COPPER 8-HYDROXYQUINOLINE

Description: Solid.

Formula: $Cu(C_9H_6NO)_2$

Constant: Mol. Wt. 351.8

Toxicity: See Copper Compounds.

Fire Hazard: Slight; when heated, it emits acrid fumes.

Storage and Handling: Section 7

COPPER NAPHTHENATE

Description: A solid.

Formula: $(C_6H_5COO)_2Cu$
Constants:
  Mol. Wt. 221.9
  Flash P. 100°F
  Density 1.055
Toxicity: See Copper Compounds.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

COPPER NITRATE

Synonym: Cupric nitrate.
Description: Blue, deliquescent crystals.
Formula: $Cu(NO_3)_2 \cdot 3H_2O$
Constants:
  Mol. Wt. 241.63
  M. P. 114.5°C
  Density 2.047
Toxicity: See Copper Compounds and Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

COPPER NITRIDE

Description: Dark-green powder.
Formula: Cu_3N
Constants:
  Mol. Wt. 204.63
  M. P. Decomposes 300°C
Toxicity: See Copper Compounds and Nitrides.
Disaster Control: See Nitrides.
Storage and Handling: Section 7

COPPER NITRODITHIOACETATE

Description: Solid.
Toxicity: See Copper Compounds.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

COPPER OLEATE

Synonym: Cupric oleate.
Description: Brown powder or greenish-blue mass.
Formula: $Cu(C_{18}H_{33}O_2)_2$
Constant:
  Mol. Wt. 626.46
Toxicity: See Copper Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

COPPER OXALATE

Synonym: Cupric oxalate.
Description: Solid; light bluish-green powder.
Formula: $CuC_2O_4 \cdot \frac{1}{2} H_2O$
Constant:
  Mol. Wt. 160.57
Toxicity: See Oxalates.

COPPER OXIDE

Synonym: Cupric oxide; parmelaconite.
Description: Fine, black powder.
Formula: CuO
Constants:
  Mol. Wt. 79.5
  B. P. Decomposes @1026°C
  Density 6.4
Toxicity: See Copper Compounds.

COPPER OXIDE, RED. See Cuprous Oxide.

COPPER OXYCHLORIDE

Synonyms: Brunswick green; cupric oxychloride.
Description: Emerald green to greenish-black powder.
Formula: $CuCl_2 \cdot 2CuO \cdot 4H_2O$
Constants:
  Mol. Wt. 365.60
  M. P. $-3H_2O$ @140°C
Toxicity: See Copper Compounds.

COPPER 2,4-PENTANEDIONE DERIVATIVE

Synonym: Acetylacetonate of copper.
Description: Blue crystals.
Formula: $Cu(C_6H_7O_2)_2$
Constants:
  Mol. Wt. 261.75
  M. P. > 230°C
  B. P. Sublimes
Toxicity: See Copper Compounds.

COPPER PERCHLORATE

Description: Crystalline.
Formula: $Cu(ClO_4)_2 \cdot 6H_2O$
Constants:
  Mol. Wt. 370.6
  M. P. 60°C
Toxicity: See Perchlorates.
Fire Hazard: See Perchlorates.
Explosion Hazard: See Perchlorates.
Disaster Control: See Perchlorates.
Storage and Handling: Section 7

COPPER PEROXIDE

Description: Brown or brownish-black

crystals.
Formula: $CuO_2 \cdot H_2O$
Constant:
Mol. Wt. 113.56
Toxicity: See Copper Compounds and Peroxides.
Fire Hazard: See Peroxides.
Disaster Control: See Peroxides.
Storage and Handling: Section 7

COPPER 3-PHENYL SALICYLATE

Description: An odorless, nonvolatile crystalline material.
Formula: $C_{26}H_{18}CuO_6$
Constants:
Mol. Wt. 490.0
M. P. 145°C
Toxicity: See Copper Compounds.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7.

COPPER PHOSPHATE

Synonym: Cupric phosphate.
Description: Solid; bluish-green powder.
Formula: $Cu_3(PO_4)_2$
Constant:
Mol. Wt. 380.6
Toxicity: See Copper Compounds.

COPPER PHOSPHIDE

Synonym: Cupric phosphide.
Description: Solid.
Formula: Cu_3P_2
Constants: Mol. Wt. 252.6
M. P. Decomp.
Density 6.67
Toxicity: See Phosphides.
Fire Hazard: Upon reaction with water, phosphine, which is spontaneously flammable in air, is evolved. See also Phosphides.
Explosion Hazard: See Phosphides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid, acid fumes, water or steam, it will react to produce toxic and flammable fumes of phosphine.
Storage and Handling: Section 7

COPPER PICRATE

Description: A solid.
Formula: $Cu(C_6H_2N_3O_7)_2$
Constant:
Mol. Wt. 519.7
Toxicity: See Picrates and Copper Compounds.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates and Explosives, High.
Disaster Control: Highly dangerous; shock and heat will explode it; when heated to decomposition it emits highly toxic fumes.
Storage and Handling: Section 7

COPPER POLYSULFIDE. See Cuprous Sulfide.

COPPER PROPARGYLATE

Description: A solid.
Toxicity: See Copper Compounds.
Explosion Hazard: Severe, when shocked or exposed to heat. See also Explosives, High.
Disaster Control: Dangerous; shock and heat will explode it.
Storage and Handling: Section 7

COPPER PROPIONYL ACETATE

Description: Crystals.
Formula: CuC_5H_9O
Constant:
Mol. Wt. 148.7
Toxicity: See Copper Compounds.

COPPER-8-QUINOLINOLATE

Synonyms: Copper-8-hydroxyquinoline.
Description: Yellow-green powder.
Formula: $C_{18}H_{12}N_2O_2Cu$
Constants: Mol. Wt. 351.83
Decomposes @210°C
Toxicity: See Copper Compounds.
Fire Hazard: Slight; on decomposition it emits toxic fumes.
Storage and Handling: Section 7

COPPER RESINATE

Description: Green powder.
Formula: $Cu(C_{20}H_{29}O_2)_2$
Constant:
Mol. Wt. 666.43
Toxicity: See Copper Compounds.
Fire Hazard: Slight, when exposed to heat (Section 6).
Storage and Handling: Section 7

COPPER RICINOLEATE

Description: A green, plastic solid.
Formula: $Cu[CO_2(CH_2)_7CHCHCH_2CH OH(CH_2)_5CH_3]_2$
Constant:
Mol. Wt. 654
Softening Point: 64°C

Toxicity: See Copper Compounds.
Fire Hazard: Slight; when heated it emits toxic fumes.
Storage and Handling: Section 7

COPPER SEBACATE

Description: A solid.
Formula: $Cu(CH_2)_8C_2O_4$
Constant:
Mol. Wt. 263.8
Toxicity: See Copper Compounds.
Fire Hazard: Slight, when exposed to heat (Section 6).
Storage and Handling: Section 7

COPPER SILICATE

Description: Greenish crystals.
Formula: $CuSiO_3$
Constant:
Mol. Wt. 139.6
Toxicity: See Copper Compounds and Silicates.

COPPER SILICIDE

Description: White metallic crystals.
Formula: Cu_4Si
Constants:
Mol. Wt. 282.22
M. P. 850°C
Density 7.53
Toxicity: See Copper and Silicon Compounds.
Fire Hazard: See Silane and Hydrogen.
Explosion Hazard: See Silane and Hydrogen.
Disaster Control: Moderately dangerous; it will react with water or steam to produce hydrogen and flammable vapors; on contact with acid or acid fumes, it can emit toxic fumes.
Storage and Handling: Section 7

COPPER SILICOFLUORIDE. See Cupric Fluosilicate.

COPPER STEARATE

Synonym: Cupric stearate.
Description: Light-blue, amorphous powder.
Formula: $Cu(C_{18}H_{35}O_2)_2$
Constants:
Mol. Wt. 630.50
M. P. 125°C
Toxicity: See Copper Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

COPPER SUBOXIDE

Description: Olive-green crystals.
Formula: Cu_4O
Constants:
Mol. Wt. 270.16
M. P. Decomposes
Toxicity: See Copper Compounds.

COPPER SUBSULFATE

Synonym: Cupric sulfate, basic.
Description: Light-blue powder.
Formula: $4CuO \cdot SO_3$
Constant:
Mol. Wt. 398.2
Toxicity: See Copper Compounds.

COPPER SULFATE

Synonyms: Blue vitriol; blue stone; Roman vitriol.
Description: Blue crystals or blue, crystalline granules or powder.
Formula: $CuSO_4 \cdot 5H_2O$
Constants:
Mol. Wt. 249.71
M. P. $-4H_2O$ @110°C
Density 2.284
Toxicity: See Copper Compounds.

COPPER SULFATE, AMMONIATED

Synonyms: Cupric sulfate, ammoniated.
Description: Dark-blue crystals.
Formula: $CuSO_4 \cdot 4NH_3 \cdot H_2O$
Constants:
Mol. Wt. 245.8
Toxicity: See Copper Compounds and Ammonia.

COPPER SULFIDE

Synonym: Cupric sulfide.
Description: Black powder or crystals.
Formula: CuS
Constants:
Mol. Wt. 95.6
M. P. Transition @103°C
B. P. Decomposes @220°C
Density 4.6
Toxicity: See Copper Compounds and Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid, acid fumes, water or steam, it will react to produce toxic and flammable vapors of hydrogen sulfide.
Storage and Handling: Section 7

COPPER TELLURITE

Description: Green solid.
Formula: $CuTeO_3$
Constant: Mol. Wt. 239.15
Toxicity: See Tellurium Compounds and Copper Compounds.
Disaster Control: Moderately dangerous; when heated to decomposition or on contact with acid or acid fumes, it can emit toxic fumes of hydrogen telluride.
Storage and Handling: Section 7

COPPER TETRAZOL

Toxicity: See Copper Compounds.
Explosion Hazard: Severe, when exposed to heat or shock.
Disaster Control: Highly dangerous; shock and heat will explode it; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

COPPER THIOCYANATE

Synonym: Cuprous thiocyanate.
Description: White to yellowish powder.
Formula: CuCNS
Constants:
Mol. Wt. 121.6
M. P. 1084°C
Density 2.85
Toxicity: See Copper Compounds and Thiocyanates.
Disaster Control: See Thiocyanates.
Personnel Protection: Section 3
Storage and Handling: Section 7

"COPPER THIURAM"

Toxicity: See Copper Compounds.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

COPPER TRICHLOROPHENATE

Description: A crystalline solid.
Formula: $Cu(Cl_3C_6H_2O)_2$
Constant:
Mol. Wt. 456.5
Toxicity: See Chlorophenols and Copper Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

COPPER XANTHATE

Synonym: Copper ethylxanthogenate.
Description: Yellow precipitate.
Formula: $Cu(C_3H_5OS_2)_2$
Constants:
Mol. Wt. 305.94
M. P. Decomposes
Toxicity: See Copper Compounds.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

COPRA

Toxicity: Unknown.
Fire Hazard: Moderate, when exposed to heat, dangerous if stored wet and hot (Section 6).
Spontaneous Heating: Slight
Storage and Handling: Section 7
Shipping Regulations: Section 7
Coast Guard Classification: Hazardous article.

CORDEAU DETONANT FUSE

See Explosives, High.
Shipping Regulations: Section 11.
I. C. C. Classification: Explosive C.
Coast Guard Classification: Explosive C.

CORDITE. See Smokeless Powder.

CORN MEAL FEEDS

Toxicity: Weak allergens. Local contact can cause contact dermatitis. Inhalation or ingestion may provoke bronchial asthma, eczema, hives, angioedema, conjunctivitis, rhinorrhea, etc. in already sensitized persons (Section 9).
Fire Hazard: Slight, when exposed to heat (Section 6).
Spontaneous Heating: High. A safe moisture content must be retained. Presence of oil may be dangerous during storage.
Storage and Handling: Section 7

CORN OIL

Description: Light-yellow, clear, oily liquid; faint characteristic odor.
Constants: M. P. −10°C
Flash P. 490°F (C. C.)
Density 0.92
Autoign Temp. 740°F
Toxicity: May be an allergen.
Fire Hazard: Slight, when exposed to heat or flame. Dangerous when

stored if leakage impregnates rags, waste, etc. (Section 6).
Spontaneous Heating: Moderate.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride.
Storage and Handling: Section 7

CORROSIVE LIQUID, N.O.S.

Toxicity: See Sulfuric Acid or Sodium Hydroxide.
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Shipping Regulations: Section 11.
- I. C. C. Classification: Corrosive liquid, white label.
- Coast Guard Classification: Corrosive liquid, white label.

CORROSIVE SUBLIMATE. See Mercuric Chloride.

COTARNINE CHLORIDE

Synonym: Stypticin.
Description: Light-yellow powder.
Formula: $C_{12}H_{13}NO_3HCl$
Constant: Mol. Wt. 255.64
Toxic Hazard Rating:
- Acute Local: Irritant 1; Ingestion 1; Inhalation 1
- Acute Systemic: Ingestion 3; Inhalation 3
- Chronic Local: U
- Chronic Systemic: Ingestion 1; Inhalation 1

Toxicology: Large doses cause paralysis of the central nervous system and death due to depression of the respiratory center.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

COTTON DUST

Toxic Hazard Rating:
- Acute Local: Inhalation 2
- Acute Systemic: Inhalation 2
- Chronic Local: Inhalation 2
- Chronic Systemic: Inhalation 1

Toxicology: Can cause a mild febrile condition of the lungs known as Byssinosis or Monday Fever. This resembles metal fume fever and is prevalent in plants where the dusts of such fibers are found. Immunity can be acquired after a few days of exposure. It does not ordinarily cause any fibrosis.

Coarser grades of cotton contain more dust than the finer varieties, and therefore constitute a greater hazard. It is considered an inert dust and is so within the meaning of that term. However, it can cause some illness, due to the allergens or fungi in the cotton or on the dust. Workers in processing rooms may develop conjunctivitis or blepharitis from the burned products of the gassing of the double yarn. It is a mild allergen. Inhalation may produce bronchial asthma, sneezing and eczema in sensitized persons (Section 9).

Treatment and Antidotes: Removal from exposure will usually cause symptoms to disappear. Medical attention should be given to ascertain that there is no fibrosis of the lungs.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame (Section 7).
Ventilation Control (use normal rate): Section 2

COTTON SEED

Toxicity: A very powerful allergen. Inhalation or ingestion may produce bronchial asthma, sneezing, rhinorrhea, conjunctivitis, eczema and hives in persons already sensitized to this material (Section 9).
Fire Hazard: Slight, when exposed to heat (Section 6).
Spontaneous Heating: Low. If piled or stored wet and hot, it can generate dangerous amounts of heat.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
- Coast Guard Classification: Hazardous article.

COTTONSEED OIL (REFINED)

Description: Pale oily, yellow, nearly odorless liquid from seeds of species of Gossypium.

Constants:
  Flash P. 486°F (C.C.)
  Freezing P. 0 to −5°C
  Density 0.915 - 0.921 @25°/25°C
  Autoign. Temp. 650°F
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: 0
  Chronic Local: Allergen 1
  Chronic Systemic: 0
Fire Hazard: Slight, when exposed to heat or flame. However, if allowed to impregnate rags or oily waste, it can be a dangerous hazard (Section 6).
Spontaneous Heating: Moderate.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride.
Personal Hygiene: Section 3
Storage and Handling: Section 7

COTTON WASTE, OILY, WITH MORE THAN 5% ANIMAL OR VEGETABLE OIL.

Toxicity: No rating
Fire Hazard: Moderate; when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid; yellow label.

COUMARIN

Synonym: 1,2-benzopyrone.
Description: Crystals; fragrant, pleasnat odor; burning taste.
Formula: $C_9H_6O_2$
Constants: Mol. Wt. 146.1
  M. P. 70°C
  B. P. 291.0°C
  Vap. Press. 1 mm @106.0°C
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: Ingestion 1; Inhalation 1
  Chronic Local: Allergen 1
  Chronic Systemic: U
Toxicology: The parent substance of dicoumerol, which causes disturbances in the clotting mechanism of the blood, and hence can lead to spontaneous bleeding.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

CREOSOTE, COAL TAR

Synonym: Creosote oil.
Description: Colorless or yellow clear, oily liquid.
Composition: A mixture of phenols from coal tar.
Constants:
  B. P. 200 - 250°C
  Flash P. 165°F (C.C.)
  Density 1.07
  Autoign. Temp. 637°F
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: Irritant 2; Allergen 2
  Chronic Systemic: Ingestion Inhalation 2
Fire Hazard: Moderate, when exposed to heat or flame.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Ventilation Control: (use moderate rate).
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  Coast Guard Classification: Combustible liquid.
  MCA warning label.

CREOSOTE (CRESOL AND PHENOL) MIXTURE. See Cresol and Phenol.

CREOSOTE OIL. See Creosote, Coal Tar.

CRESOL

Synonyms: Cresylic acid, cresylol, tricresol.
Description: (U.S.P.X.) mixture of isomeric cresols obtained from coal tar; colorless or yellowish to brown yellow or pinkish liquid, phenol-like odor.
Formula: $C_6H_4OHCH_3$
Constants:
  Mol. Wt. 108.10
  M. P. 10.9 -35.5°C
  B. P. 191 -203°C

Flash P. 110°F
Density 1.030-1.038 @25°/25°C
Vap. Press. 1 mm @38 - 53°C
Vap. D. 3.72
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 1; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Chronic Local: Irritant 3; Allergen 1
Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
MAC: ACGIH (accepted); 22 milligrams per cubic meter of air; 5 parts per million in air.

Toxicology: Cresol is similar to phenol in its action on the body, but it is less severe in its effects. It has corrosive action on the skin and mucous membranes. Systemic poisoning has rarely been reported, but it is possible that absorption may result in damage to the kidneys, liver and nervous system. The main hazard accompanying its use in industry lies in its action on the skin and mucous membranes, with production of severe chemical burns and dermatitis (Section 9).

Fire Hazard: Moderate, when exposed to heat or flame.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Slight, in the form of vapor when exposed to heat or flame (Section 7).

Explosive Range: 1.35% @300°F

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; it can react vigorously with oxidizing materials.

Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Inflammable liquid.
MCA warning label.

meta-**CRESOL**

Synonym: meta-Methylphenol.

Description: Colorless to yellowish liquid, phenolic odor.

Formula: C_7H_8O

Constants:
Mol. Wt. 108.1
M. P. 10.9°C
B. P. 202.8°C
Flash P. 187°F
Density 1.034@ 20°/4°C
Autoign. Temp. 1159°F
Vap. Press. 1 mm @52.0°C
Vap. D. 3.72
Toxicity: See Cresol.
Fire Hazard: See Cresol.
Explosion Hazard: Moderate, in the form of vapor when exposed to heat or flame (Section 7).
Explosive Range: 1.06%@302°F
Disaster Control: See Cresol.
Storage and Handling: Section 7
MCA warning label.

ortho-**CRESOL**

Synonyms: ortho-Cresylic acid; ortho-hydroxytoluene.

Description: Crystals or liquid darkening with exposure to air and light.

Formula: C_7H_8O

Constants: Mol. Wt. 108.1
M. P. 30.8°C
B. P. 190.8°C
Flash P. 178°F
Density 1.047 @20°/4°C
Autoign. Temp. 110°F
Vap. Press. 1 mm @38.2°C
Vap. D. 3.72
Toxicity: See Cresol.
Fire Hazard: See Cresol.
Explosion Hazard: See Cresol.
Disaster Control: See Cresol.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Inflammable liquid.
MCA warning label.

para-**CRESOL**

Synonyms: 4-cresol.

Description: Crystals, phenolic odor.

Formula: C_7H_8O

Constants:
Mol. Wt. 108.1
M. P. 35.5°C
B. P. 201.8°C
Flash P. 187°F

Density 1.0341 @20°/4°C
Autoign. Temp. 1159°F
Vap. Press. 1 mm @53.0°C
Vap. D. 3.72
Toxicity: See Cresol.
Fire Hazard: Moderate, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, in the form of vapor when exposed to heat or flame (Section 7).
Explosive Range: 1.06% @302°F.
Disaster Control: See Cresol.
Storage and Handling: Section 7
MCA warning label.

o-CRESOTINIC ACID

Description: White to yellowish needle-like crystals.
Formula: $C_6H_3(CH_3)(OH)COOH$
Constants:
Mol. Wt. 152.1
M. P. 166°C Sublimes
Toxicity: Unknown
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

CRESYL DIPHENYL PHOSPHATE

Description: Liquid
Formula:
$(C_6H_5O)_2[(CH_3)_2C_6H_4O]PO_4$
Constants:
Mol. Wt. 403.3
B. P. 734°F
Flash P. 450°F
Density 1.208
Vap. D. 11.7
Toxicity: See Phosphorus Compounds.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes.
Storage and Handling: Section 7

CRESYLIC ACID. See Cresol.

CRISTOBALITE. See Silica.

CROTONALDEHYDE

Synonyms: 2-Butenal; crotonic aldehyde; beta-methyl acrolein.
Description: Water-white mobile liquid; pungent suffocating odor.
Formula: $CH_3CHCHCHO$
Constants:
Mol. Wt. 70.09
B. P. 104°C
Freezing P. −76.0°C
Flash P. 55°F
Density 0.853 @20°/20°C
Vap. D. 2.41
Toxic Hazard Rating:
Acute Local: Irritant 3; Allergen 2; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: Allergen 2
Chronic Systemic: U
Toxicology: A lachrymating material which is very dangerous to the eyes. Can cause corneal burns and is irritating to the skin.
Treatment and Antidotes: In case of contact, immediately flush the skin or eyes with water for at least 15 minutes. Get medical attention.
Fire Hazard: Dangerous, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, in the form of vapor when exposed to heat or flame (Section 7).
Explosive Range: 2.95 - 15.5%
Disaster Control: Dangerous; keep away from heat and open flame.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

CROTONIC ACID

Synonym: beta-methacrylic acid.
Description: Colorless needle-like crystals.
Formula: $CH_3CHCHCOOH$
Constants: Mol. Wt. 86.09
B. P. 172°C
M. P. 15°C
Freezing P. 72°C

Flash P. 190°F (C.O.C.)
Density 1.018 @20°/4°C
Vap. Press. 0.19 mm @20°C
Vap. D. 2.97
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

CROTON OIL

Synonym: Tiglium oil.
Description: Brownish-yellow, viscid oil, slight offensive odor.
Composition: Croton resin, glycerides of fatty acids and crotin.
Constant:
Density 0.935 - 0.950 @25°/25°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 1; Ingestion 3
Acute Systemic: Ingestion 3
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits smoke (Section 6).
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

CROTONYLENE

Description: Liquid.
Formula: CH_3CCCH_3
Constants: Mol. Wt. 54.09
B. P. 83°F
Flash P. 64°F
Density 0.688 @25°C
Vap. D. 1.91
Toxicity: Details unknown.
Fire Hazard: Dangerous, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, in the form of vapor when exposed to heat or flame.
Explosive Range 1.37% (L.E.L.)
Storage and Handling: Section 7

CRUDE NITROGEN FERTILIZER SOLUTION. See Compressed Gases, N.O.S.
Shipping Regulations: Section 11.
I.C.C. Classification: Nonflammable gas; green label.
Coast Guard Classification: Noninflammable gas; green label.

CRUDE OIL (PETROLEUM)

Synonyms: Earth oil; Seneca oil.
Description: Thick, flammable liquid, dark-yellow to brown or green-black.
Composition: A mixture of hydrocarbons.
Constant:
Density 0.780 - 0.970
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1; Ingestion 2; Inhalation 1
Acute Systemic: U
Chronic Local: Irritant 2; Allergen 1
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; it can react with oxidizing materials.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

CRYOLITE. See Sodium Fluoaluminate.

CRYPTOPINE

Description: White, crystalline powder.
Formula: $C_{21}H_{23}NO_5$
Constants:
Mol. Wt. 369.4
M. P. 217°C Decomposes
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3
Caution: Related to opium in derivation and action.
Disaster Control: Dangerous; when

heated to decomposition it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

CRYPTOPINE HYDROCHLORIDE.
See Cryptopine.

CUMENE
Synonyms: Isopropylbenzene; 2-phenylpropane; cumol.
Description: Colorless liquid.
Formula: $C_6H_5CH(CH_3)_2$
Constants:
- Mol. Wt. 120.19
- M. P. −96.0°C
- B. P. 152°C
- Flash P. 102°F
- Density 0.864 @20°/4°C
- Vap. Press. 10 mm @38.3°C

Toxic Hazard Rating:
- Acute Local: Irritant 1
- Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
- Chronic Local: Irritant 2
- Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2

Toxicology: Cumene has a potent narcotic action characterized by a slow induction period, although the effects are of long duration. It is a depressant to the central nervous system and the minimum lethal concentration for mice is 2,000 ppm. The long duration of its action indicates a possible slow rate of elimination, meaning that possible cumulative effects must be considered. It is thought to have a greater acute toxicity than benzene or toluene; there is no apparent difference between the toxicity of pure cumene or that derived from petroleum. See also Benzene and Toluene.
Fire Hazard: Moderate, when exposed to flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

CUMENE HYDROPEROXIDE
Synonym: alpha-Dimethyl benzyl hydroperoxide.
Description: Colorless to pale-yellow liquid.
Constants:
- B. P. 153°C
- Flash P. 198°F
- Density 1.05

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Moderate, when exposed to heat or flame; it can react with reducing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Caution: A strong oxidizing agent. See Peroxides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
- I. C. C. Classification: Oxidizing material; yellow label.
- Coast Guard Classification: Oxidizing material; yellow label.

p-alpha-CUMYL PHENOL
Description: White to light tan crystals.
Formula: $C_6H_5C(CH_3)_2C_6H_4OH$
Constants:
- Mol. Wt. 212.3
- B. P. 187°C @10 mm
- Freezing P. 70°C
- Flash P. 320°F

Toxicity: Unknown
Fire Hazard: Slight; when exposed to heat or flame; it can react with oxidizing materials (Section 6).
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride.
Storage and Handling: Section 7

CUPRIC ACETATE m-ARSENATE
Synonym: Paris Green.

Description: Emerald green powder.
Formula: $Cu(C_2H_3O_2)_2 \cdot 3Cu(AsSo_2)_2$ (approx.)
Constant:
Mol. Wt. 1013.71
Toxicity: See Arsenic Compounds.
Disaster Control: Dangerous; when heated to decomposition, or on contact with acid or acid fumes, it emits highly toxic fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

CUPRIC o-ARSENATE
Description: Bluish-green crystals.
Formula: $Cu_3(AsO_4)_2 \cdot 4H_2O$
Constant:
Mol. Wt. 540.50
Toxicity: See Arsenic Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

CUPRIC ARSENATE, BASIC
Description: Green powder.
Formula: $Cu_3(AsO_4)_2Cu(OH)_2$
Constant:
Mol. Wt. 566
Toxicity: See Arsenic Compounds
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

CUPRIC m-ARSENITE
Description: Powder.
Formula: $Cu(AsO_2)_2 \cdot H_2O$
Constant:
Mol. Wt. 295.4
Toxicity: See Arsenic Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits toxic fumes.
Storage and Handling: Section 7

CUPRIC BENZOATE
Description: Light-blue, crystalline powder.
Formula: $Cu(C_7H_5O_2)_2 \cdot 2H_2O$
Constants:
Mol. Wt. 341.8
M. P. $-2H_2O$ @110°C
Toxicity: See Copper Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

CUPRIC m-BORATE
Description: Bluish-green, crystalline powder.
Formula: $Cu(BO_2)_2$
Constants:
Mol. Wt. 149.18
Density 3.859
Toxicity: See Copper Compounds and Boron Compounds.

CUPRIC BROMATE
Description: Cubic blue-green crystals.
Formula: $Cu(BrO_3)_2 . 6H_2O$
Constants: Mol. Wt. 427.47
M. P. Decomposes 180°C
$-6H_2O$ @200°C
Density 2.583
Toxicity: See Bromates.
Fire Hazard: See Bromates.
Disaster Control: See Bromates.
Storage and Handling: Section 7

CUPRIC BROMIDE
Description: Monoclinic black, deliquescent crystals.
Formula: $CuBr_2$
Constants:
Mol. Wt. 223.37
M. P. 498°C
Toxicity: See Bromides.

CUPRIC BUTYRATE
Description: Dark-green crystals, odor of butyric acid.
Formula: $Cu(C_4H_7O_2)_2 \cdot 2H_2O$
Constant:
Mol. Wt. 273.8
Toxicity: See Copper Compounds.

CUPRIC CHLORATE
Description: Cubic green, deliquescent crystals.

Formula: $Cu(ClO_3)_2 \cdot 6H_2O$
Constants:
Mol. Wt. 338.55
M. P. 65°C
B. P. Decomposes 100°C
Toxicity: See Chlorates.
Fire Hazard: See Chlorates.
Explosion Hazard: See Chlorates.
Disaster Control: See Chlorates.
Storage and Handling: Section 7

CUPRIC CHLORIDE. See Copper Chloride.

CUPRIC CHROMATE, BASIC

Description: Yellow-brown crystals.
Formula: $CuCrO_4 \cdot 2CuO \cdot 2H_2O$
Constants:
Mol. Wt. 374.66
M. P. $-2H_2O$ @260°C
Toxicity: See Chromium Compounds and Copper Compounds.
Fire Hazard: Slight; by reaction with reducing agents (Section 6).
Storage and Handling: Section 7

CUPRIC CITRATE

Description: Bluish-green powder.
Formula: $2Cu_2C_6H_4O_7 \cdot 5H_2O$
Constant:
Mol. Wt. 720.42
Toxicity: See Copper Compounds.

CUPRIC CYANIDE. See Copper Cyanide.

CUPRIC DICHROMATE

Description: Black, deliquescent crystals.
Formula: $CuCr_2O_7 \cdot 2H_2O$
Constants:
Mol. Wt. 315.59
M. P. $-2H_2O$ @100°C
Density 2.283
Toxicity: See Chromium Compounds and Copper Compounds.
Fire Hazard: Moderate, by reaction with reducing agents.
Storage and Handling: Section 7

CUPRIC DIHYDROGEN o-ARSENATE

Description: Blue crystals.
Formula: $Cu_5H_2(AsO_4)_4 \cdot 2H_2O$
Constant: Mol. Wt. 911.39
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

CUPRIC ETHYLACETOACETATE

Description: Green needles.
Formula: $Cu(C_6H_9O_3)_2$
Constants:
Mol. Wt. 321.80
M. P. 192°C
B. P. Sublimes
Toxicity: See Copper Compounds.

CUPRIC FERRICYANIDE

Description: Yellow-green crystals.
Formula: $Cu_3(Fe(CN)_6)_2$
Constant:
Mol. Wt. 870.76
Toxicity: See Ferricyanides.
Disaster Control: See Ferricyanides.
Storage and Handling: Section 7

CUPRIC FLUORIDE. See Copper Fluoride.

CUPRIC FLUOSILICATE

Description: Monoclinic prisms.
Formula: $CuSiF_6 \cdot 4H_2O$
Constants:
Mol. Wt. 277.66
Density 2.158
Toxicity: See Fluosilicates.
Disaster Control: See Fluosilicates.
Storage and Handling: Section 7

CUPRIC FORMATE

Description: Monoclinic, blue crystals.
Formula: $Cu(CHO_2)_2$
Constants:
Mol. Wt. 153.58
Density 1.831
Toxicity: See Copper Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

CUPRIC GLYCERINE DERIVATIVE

Description: Blue needles.
Formula: $Cu(C_2H_4NO_2)_2 \cdot 2H_2O$
Constants:
Mol. Wt. 229.68
M. P. $-H_2O$ @130°C
Toxicity: See Copper Compounds.

CUPRIC HYDROXIDE. See Copper Hydroxide.

CUPRIC IODATE

Description: Monoclinic, green crystals.
Formula: $Cu(IO_3)_2$

Constants:
Mol. Wt. 413.38
M. P. Decomposes
Density 5.241 @15°C
Toxicity: See Iodates.
Fire Hazard: See Iodates.
Disaster Control: See Iodates.
Storage and Handling: Section 7

CUPRIC LACTATE

Description: Monoclinic, dark blue crystals.
Formula: $Cu(C_3H_5O_3)_2 \cdot 2H_2O$
Constant:
Mol. Wt. 277.71
Toxicity: See Copper Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

CUPRIC LAURATE

Description: Light-blue powder.
Formula: $Cu(C_{12}H_{23}O_2)_2$
Constants:
Mol. Wt. 462.15
M. P. 111 - 113°C
Toxicity: See Copper Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

CUPRIC NITRATE. See Copper Nitrate.

CUPRIC NITROPRUSSIDE

Description: White-greenish powder.
Formula: $CuFe(CN)_5NO \cdot 2H_2O$
Constant:
Mol. Wt. 315.52
Toxicity: See Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

CUPRIC OLEATE. See Copper Oleate.

CUPRIC OXALATE. See Copper Oxalate.

CUPRIC OXIDE. See Copper Oxide.

CUPRIC OXYCHLORIDE. See Copper Oxychloride.

CUPRIC PALMITATE

Description: Green-blue powder.
Formula: $Cu(C_{16}H_{31}O_2)_2$
Constants:
Mol. Wt. 574.36
M. P. 120°C
Toxicity: See Copper Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

CUPRIC PARAPERIODATE

Description: Green powder.
Formula: Cu_2HIO_6
Constants:
Mol. Wt. 351.01
M. P. Decomposes 110°C
Toxicity: See Copper Compounds and Iodates.
Fire Hazard: See Iodates.
Disaster Control: See Iodates.
Storage and Handling: Section 7

CUPRIC PHENOLSULFONATE

Description: Bluish-green crystals.
Formula: $Cu[C_6H_4(OH)SO_3]_2 \cdot 6H_2O$
Constant:
Mol. Wt. 518.0
Toxicity: See Copper Compounds and Phenosulfonates.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

CUPRIC o-PHOSPHATE. See Copper Phosphate.

CUPRIC SALICYLATE

Description: Blue-green needles.
Formula: $Cu(C_7H_5O_3)_2 \cdot 4H_2O$
Constant:
Mol. Wt. 409.8
Toxicity: See Copper Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

CUPRIC SELENATE

Description: Blue, triclinic crystals.
Formula: $CuSeO_4 \cdot 5H_2O$
Constants:
Mol. Wt. 296.58
Density 2.559
Toxicity: See Selenium Compounds and Copper Compounds.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

CUPRIC STEARATE. See Copper Stearate.

CUPRIC SULFATE. See Copper Sulfate.

CUPRIC SULFIDE. See Copper Sulfide.

CUPRIC TARTRATE
Description: Light-blue powder.
Formula: $CuC_4H_4O_6$
Constant:
Mol. Wt. 211.6
Toxicity: See Copper Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

CUPRIC THIOCYANATE
Description: Black crystals.
Formula: $Cu(SCN)_2$
Constants:
Mol. Wt. 179.71
M. P. Decomposes @100°C
Toxicity: See Thiocyanates.
Disaster Control: See Thiocyanates.
Storage and Handling: Section 7

CUPRIC TUNGSTATE
Description: Light-green crystals.
Formula: $CuWO_4 \cdot 2H_2O$
Constants:
Mol. Wt. 347.49
M. P. @red heat
Toxicity: See Copper Compounds and Tungsten Compounds.

CUPROUS ACETYLIDE
Description: Amorphous red powder.
Formula: Cu_2C_2
Constants:
Mol. Wt. 150.10
M. P. Explodes
Toxicity: See Copper Compounds.
Explosion Hazard: Severe when shocked or exposed to heat (Section 7).
Disaster Control: Highly dangerous; shock and heat will explode it.
Storage and Handling: Section 7

CUPROUS BROMIDE
Description: White crystals.
Formula: CuBr
Constants:
Mol. Wt. 143.66
M. P. 504°C
B. P. 1355°C
Density 4.718
Vap. Press. 1 mm @572°C
Toxicity: See Bromides.

CUPROUS CARBONATE
Description: Yellow crystals.
Formula: Cu_2CO_3
Constants:
Mol. Wt. 187.1
M. P. Decomposes
Density 4.40
Toxicity: See Copper Compounds.

CUPROUS CHLORIDE
Synonym: Nantokite.
Description: Cubic, white crystals.
Formula: CuCl
Constants:
Mol. Wt. 99.00
M. P. 422°C
B. P. 1366°C
Density 3.53
Vap. Press. 1 mm @546°C
Toxicity: See Chlorides.

CUPROUS CYANIDE
Description: Monoclinic, white prisms.
Formula: CuCN
Constants:
Mol. Wt. 89.56
M. P. 473°C in N_2
B. P. Decomposes
Density 2.92
Toxicity: See Cyanides.
Fire Hazard: See Cyanides.
Explosion Hazard: See Cyanides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid, acid fumes, water or steam, it will react to produce toxic and flammable vapors of hydrogen cyanide.
Storage and Handling: Section 7

CUPROUS FERRICYANIDE
Description: Brown-red crystals.
Formula: $Cu_3Fe(CN)_6$
Constant:
Mol. Wt. 402.59
Toxicity: See Ferricyanides.
Disaster Control: See Ferricyanides.
Storage and Handling: Section 7

CUPROUS FLUOGALLATE
Description: Pale-blue crystals.
Formula: $(Cu(H_2O)_6)(GaF_5 \cdot H_2O)$
Constants:
Mol. Wt. 354.37
M. P. $-5H_2O$ @110°C
Density 2.20
Toxicity: See Fluogallates and Copper Compounds.

Disaster Control: See Fluogallates.
Storage and Handling: Section 7

CUPROUS FLUORIDE
Description: Red crystals.
Formula: CuF
Constants:
Mol. Wt. 82.54
M. P. 908°C
B. P. Sublimes @1100°C
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

CUPROUS FLUOSILICATE
Synonym: Cuprous silicofluoride.
Description: Red powder.
Formula: Cu_2SiF_6
Constants:
Mol. Wt. 269.14
B. P. Decomposes
Toxicity: See Fluosilicates and Copper Compounds.
Disaster Control: See Fluosilicates.
Storage and Handling: Section 7

CUPROUS HYDROXIDE
Description: Yellow crystals.
Formula: CuOH
Constants:
Mol. Wt. 80.55
M. P. $-\frac{1}{2}H_2O$ @360°C
Density 3.37
Toxicity: See Copper Compounds.

CUPROUS IODIDE
Synonym: Marshite.
Description: Cubic, white crystals.
Formula: CuI
Constants:
Mol. Wt. 190.46
M. P. 605°C
B. P. 1290°C
Density 5.62
Vap. Press. 10 mm @656°C
Toxicity: See Iodides.

CUPROUS OXIDE
Synonym: Cuprite
Description: Octahedral, cubic red crystals.
Formula: Cu_2O
Constants:
Mol. Wt. 143.14
M. P. 1235°C
B. P. $-O_2$ @1800°C
Density 6.0
Toxicity: See Copper Compounds.

CUPROUS SELENIDE
Description: Black cubes.
Formula: Cu_2Se
Constants:
Mol. Wt. 206.04
M. P. 1113°C
Density 6.749 @30°/4°C
Toxicity: See Selenium Compounds and Copper Compounds.
Fire Hazard: See Hydrogen Selenide.
Explosion Hazard: See Hydrogen Selenide.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits toxic fumes of hydrogen selenide.
Storage and Handling: Section 7

CUPROUS SULFATE
Description: Gray powder.
Formula: Cu_2SO_4
Constants:
Mol. Wt. 223.15
M. P. + 0 @200°C
Toxicity: See Copper Compounds.

CUPROUS SULFIDE
Synonym: Chalcocite.
Description: Rhombic, black crystals.
Formula: Cu_2S
Constants:
Mol. Wt. 159.15
M. P. 1100°C
Density 5.6
Toxicity: See Sulfides and Copper Compounds.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits toxic fumes of hydrogen sulfide.
Storage and Handling: Section 7

CUPROUS SULFITE
Description: Red prisms.
Formula: $Cu_2SO_3 \cdot H_2O$
Constants:
Mol. Wt. 225.16
Density 4.46 @15°C
Toxicity: See Sulfites and Copper Compounds.
Disaster Control: See Sulfites.
Storage and Handling: Section 7

CUPROUS THIOCYANATE. See Copper Thiocyanate.

CURARE
Description: Brown, brittle, resinous mass.
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
  Chronic Local: U
  Chronic Systemic: U
Toxicology: Extremely poisonous. Visual disturbances, choking sensation, then generalized paralysis.
Treatment and Antidotes: Artificial respiration, physostigmine. Call a physician immediately.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

CURIUM
Description: An artificially produced radio-active element.
Formula: Cm
Constant:
  At. Wt. 242
Toxicity: Unknown except in relation to radioactivity.
Radiation Hazard (Section 5): Artificial isotope Cm^{242}: the permissible levels are: In body: 0.05 microcurie. In air: 2×10^{-10} microcurie per milliliter. In water: 9×10^{-4} microcurie per milliliter.
Shipping Regulations: Section 11.

CUTTING OILS
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: U
  Chronic Local: Irritant 1
  Chronic Systemic: U
Toxicology: This oil is the cause of "cutting oil" dermatitis. Although it is generally caused by an insoluble oil, it can occasionally be caused by a soluble one. Many have looked for a causative factor other than the oil itself. Bacteria have frequently been blamed, although insoluble oil is usually sterile while the soluble oils may contain bacteria. The metal slivers which occur in these oils after use have also been thought to be a reason for their irritant properties, as well as the sulfur, chlorine and inhibitors which they contain. The oil itself can plug the pores forming boils (Section 9).
Treatment and Antidotes: Disinfectant agents have been added to the oils to cut down the infectious effects. Filters have been installed in the cutting oil lines to filter out the tiny metal slivers which may irritate and cause infection of the skin. General housecleaning measures are also thought advisable to remove promptly any excess oil which gets onto the hands and skin. It has been found that occasionally changing from one oil to another may bring relief from the irritation. This would also indicate that the specific irritant is not present in all oils.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

CYAMELIDE
Synonym: Insoluble cyanuric acid.
Description: White powder.
Formula: $C_3H_3N_3O_3$
Constant:
  Mol. Wt. 129.1
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: Ingestion 3; Inhalation 3
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

CYANAMIDE
Synonyms: Carbodimide; cyanogenamide.
Description: Deliquescent crystals.
Formula: HNCNH
Constants:
  Mol. Wt. 42.05
  M. P. 42°C
  B. P. 260°C
  Flash P. 285°F
  Density 1.073
  Vap. D. 1.45
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: Ingestion 1; Inhalation 1
Toxicology: Does not contain free cyanide. Causes increase in respiration and pulse rate, lowered blood pressure and dizziness. There may be a flushed appearance of the face.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

CYANATES
Toxicity: Variable.
Disaster Control: Moderately dangerous; when heated to decomposition or on contact with acid or acid fumes, they emit toxic fumes.
Storage and Handling: Section 7

CYANIC ACID
Synonym: Isocyanic acid.
Description: A white solid.
Formula: HOCN
Constants: Mol. Wt. 43.01
  B. P. Decomp.
  Density 1.140 @0°/0°C
Toxicity: Highly toxic. See Cyanides.
Explosion Hazard: Severe.
Disaster Control: Dangerous; can explode; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes and flammable vapors.
Storage and Handling: Section 7

CYANIDE OF POTASSIUM. See Potassium Cyanide.
Shipping Regulations: Section 11.
  I.C.C. Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.

CYANIDE OF SODIUM. See Sodium Cyanide.
Shipping Regulations: Section 11.
  I.C.C. Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.

CYANIDES
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: Irritant 2
  Chronic Systemic: Ingestion 1; Inhalation 1
MAC: ACGIH (accepted); 5 milligrams per cubic meter of air.
Toxicology: The volatile cyanides resemble hydrocyanic acid physiologically inhibiting tissue oxidation and causing death through asphyxia. Cyanogen is probably as toxic as hydrocyanic acid; the nitriles are generally considered somewhat less toxic, probably because of their lower volatility. The nonvolatile cyanide salts appear to be relatively nontoxic systemically, so long as they are not ingested and care is taken to prevent the formation of hydrocyanic acid. Workers, such as electroplaters and picklers, who are daily exposed to cyanide solutions, may develop a "cyanide" rash, characterized by itching, and by macular, papular and vesicular eruptions. Frequently there is secondary infection. Exposure to small amounts of cyanide compounds over long periods of time is reported to cause loss of appetite, headache, weakness, nausea, dizziness, and

symptoms of irritation of the upper respiratory tract and eyes. See also specific compounds.
Fire Hazard: Moderate, by chemical reaction with heat, moisutre, acid; emit hydrocyanic acid (Section 6).
Caution: Many cyanides evolve hydrocyanic acid rather easily. This is a flammable gas and is highly toxic. Carbon dioxide from the air is sufficiently acidic to liberate hydrocyanic acid from cyanide solutions. See also Hydrocyanic Acid.
Explosion Hazard: See Hydrocyanic Acid.
Disaster Control: Dangerous; on contact with acid, acid fumes, water or steam, they will produce toxic and flammable vapors.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  Coast Guard Classification:
    Poison B; poison label.
  MCA warning label.

CYANOACETAMIDE
Synonyms: Nitrilomalonamide; propionamide nitrile.
Description: White powder.
Formula: $CNCH_2CONH_2$
Constants:
  Mol. Wt. 84.08
  M. P. 119°C
  B. P. Decomposes
Toxicity: Highly toxic. See Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

CYANOACETIC ACID
Synonym: Malonic acid mononitrile.
Description: White, deliquescent needles.
Formula: $CNCH_2COOH$
Constants:
  Mol. Wt. 85.06
  M. P. 66°C
  B. P. 108°C @0.15 mm
Toxicity: Highly toxic. See Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

CYANOAURIC ACID
Description: Tablets.
Formula: $HAu(CN)_4 \cdot 3H_2O$
Constants:
  Mol. Wt. 356.33
  M. P. 50°C
  B. P. Decomposes
Toxicity: Highly toxic. See Cyanides.
Fire Hazard: See Cyanides.
Explosion Hazard: See Cyanides.
Disaster Control: Dangerous; when heated to decomposition, or on contact with acid or acid fumes, it emits highly toxic fumes.
Storage and Handling: Section 7

CYANOCOBALTIC III ACID
Synonym: Cobalticcyanic acid.
Description: Colorless neddles; deliquescent.
Formula: $(H_3Co(CN)_6)_2H_2O$
Constants:
  Mol. Wt. 454.16
  M. P. Decomposes @100°C
Toxicity: See Cyanides.
Fire Hazard: See Cyanides.
Explosion Hazard: See Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

CYANOFORMIC CHLORIDE
Description: Oily liquid.
Formula: COCNCl
Constants:
  Mol. Wt. 89.49
  B. P. 126 - 128°C @750 mm
Toxicity: See Cyanides.
Disaster Control: Highly dangerous; shock can shatter the container and release it; when heated to decompostion or on contact with acid, acid fumes, water or steam, it will react to produce toxic and corrosive fumes.
Storage and Handling: Section 7

CYANOGEN
Synonyms: Ethane dinitrile; prussite.
Description: Colorless gas, pungent odor.
Formula: NCCN
Constants:
  Mol. Wt. 52.04
  M. P. −34.4°C
  B. P. −21.0°C
  Density 0.866 @17°/4°C

Toxicity: Highly toxic. See Cyanides.
Disaster Control: Dangerous; shock can shatter the compressed gas container with explosive force; when heated to decomposition or on contact with acid, acid fumes, water or steam, it will react to produce highly toxic fumes.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison A; poison gas label.
Coast Guard Classification: Poison A; poison gas label.

CYANOGEN BROMIDE

Synonym: Bromine cyanide.
Description: Colorless needles.
Formula: BrCN
Constants:
Mol. Wt. 105.93
M. P. 52°C
B. P. 61.6°C
Density 2.015 @20°/4°C
Vap. Press. 100 mm @22.6°C
Toxicity: Highly toxic. See Cyanides and Bromides.
Disaster Control: Highly dangerous; shock can shatter the container and release it; when heated to decomposition or on contact with acid, acid fumes, water or steam, it will react to produce highly toxic and corrosive fumes.
Storage and Handling: Section 7

CYANOGEN CHLORIDE

Synonym: Chlorine cyanide; CK.
Description: Colorless liquid or gas; lacrimatory and irritating odor.
Formula: CNCl
Constants:
Mol. Wt. 61.48
M. P. -6.5°C
B. P. 13.1°C
Density 1.218 @4°/4°C
Vap. Press. 1010 mm @20°C
Vap. D. 1.98
Toxicity: Highly toxic. See Cyanides and Hydrochloric Acid.
Disaster Control: Highly dangerous; shock can shatter the compressed gas container with explosive force; when heated to decomposition or on contact with water or steam, it will react to produce highly toxic and corrosive fumes.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison A; poison gas label.
Coast Guard Classification: Poison A; poison gas label.

CYANOGEN FLUORIDE

Description: Colorless gas.
Formula: CNF
Constants:
Mol. Wt. 45.02
M. P. Sublimes @-72°C
B. P. -72.6°C
Toxicity: Highly toxic. See Cyanides and Fluorides.
Disaster Control: Highly dangerous; shock can shatter the compressed gas container with explosive force; when heated to decomposition or on contact with water or steam, it will react to produce toxic and corrosive fumes.
Storage and Handling: Section 7

CYANOGEN IODIDE

Synonym: Iodine cyanide.
Description: Colorless needles.
Formula: CNI
Constants:
Mol. Wt. 152.94
M. P. 146.5°C
Vap. Press. 1 mm @25.2°C
Toxicity: Highly toxic. See Cyanides and Iodides.
Disaster Control: Highly dangerous; shock can shatter the container and release it; when heated to decomposition or on contact with water or steam, it will react to produce highly toxic and corrosive fumes.
Storage and Handling: Section 7

$2C + S + N_2$
$\rightarrow C_2SN_2$

CYANOGEN SULFIDE

Synonym: Cyanogen thiocyanate.
Description: Crystals.
Formula: NCSCN
Constants:
Mol. Wt. 84.1
M. P. 65°C
B. P. Sublimes @30-40°C
Toxicity: Highly toxic. See Cyanides and Thiocyanates.
Disaster Control: Highly dangerous; when heated to decomposition or on contact with acid, acid fumes, water or steam, it will react to produce highly toxic and corrosive fumes.
Storage and Handling: Section 7

CYANOMETHYL ACETATE
Synonym: Methyl cyanoethanoate.
Description: Colorless liquid.
Formula: $CNCH_2COOCH_3$
Constants:
Mol. Wt. 99.09
M. P. −22.5°C
B. P. 200°C
Density 1.123 @ 15°C
Toxicity: Highly toxic. See Cyanides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid, acid fumes, water or steam, it will react to produce highly toxic and flammable vapors.
Storage and Handling: Section 7

3-CYANOPYRIDINE
Description: Gray crystals.
Formula: $C_6H_4N_2$
Constants:
Mol. Wt. 104.1
M. P. 47 - 49°C
B. P. 83 - 84°C @10 mm
Toxicity: Details unknown; probably highly toxic.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes; on contact with acid, acid fumes, water or steam, it will react to produce toxic and flammable vapors; it can react with oxidizing materials.
Storage and Handling: Section 7

N-CYANURIC ACID
Synonyms: sym-triazinetriol; tricyanic acid.
Description: Crystals.
Formula: $C_3H_3N_3O_3$
Constants: Mol. Wt. 129.1
M. P. > 360°C
Density 2.500 @20°/4°C
Toxicity: Highly toxic. See Cyanides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes.
Storage and Handling: Section 7

CYANURIC CHLORIDE
Synonyms: Trichloro - s - triazine; trichlorocyanidine; tricyanogen chloride.
Description: Monoclinic, colorless crystals; pungent odor.
Formula: $C_3Cl_3N_3$
Constants:
Mol. Wt. 184.43
M. P. 145.8°C
B. P. 190°C
Density 1.32 @20°/4°C
Vap. Press. 2 mm @70°C
Vap. D. 6.36
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: Allergen 2
Chronic Systemic: U
Disaster Control: Moderately dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

CYANURIC TRIAZIDE
Toxicity: Details unknown. See also Cyanides and Azides.
Explosion Hazard: Severe, when shocked or exposed to heat.
Disaster Control: Dangerous, shock and heat will explode it; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes.
Storage and Handling: Section 7

"CYCLINE OIL". See Mineral Oil, Vegetable Oil.

CYCLOBUTANE
Synonym: Tetraethylene.
Description: A gas.
Formula: C_4H_8
Constants:
Mol. Wt. 56.10
M. P. −50°C
B. P. 12.9°C
Flash P. Below 50°F (C. C.)
Density 0.708 @11°C
Vap. D. 1.93
Toxicity: Details unknown. May be a simple asphyxiant. See also Cycloparaffins.
Fire Hazard: Dangerous when exposed to heat or flame; can react with oxidizing materials.

Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or water spray (Section 6).
Storage and Handling: Section 7

CYCLOBUTENE

Synonym: Cyclobutylene; tetramethylene.
Description: Gas.
Formula: C_4H_6
Constants:
  Mol. Wt. 54.1
  B. P. 2.4°C
  Density 0.733 @ 0°/4°C
Toxicity: Details unknown. May be a simple asphyxiant.
Fire Hazard: Dangerous, when exposed to heat or flame; it can react with oxidizing materials.
Storage and Handling: Section 7

CYCLOHEPTANE

Synonym: Suberane.
Description: An oil.
Formula: C_7H_{14}
Constants:
  Mol. Wt. 98.2
  M. P. -12°C
  B. P. 244°F
  Flash P. Below 100°F
  Density 0.8099 @20°/4°C
  Vap. D. 3.3
Toxicity: Details unknown. See Cycloparaffins.
Fire Hazard: Dangerous, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemicl or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

CYCLOHEXANE

Synonyms: Hexahydrobenzene; hexamethylene.
Description: Colorless mobile liquid, pungent odor.
Formula: C_6H_{12}
Constants: Mol. Wt. 84.16
  M. P. 6.5°C
  B. P. 80.7°C
  Freezing P. 4.6°C
  Flash P. 1°F (C.C.)
  Density 0.7791 @20°/4°C
  Autoign. Temp. 514°F
  Vap. Press. 100 mm @60.8°C
  Vap. D. 2.90
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Inhalation 2
  Chronic Local: U
  Chronic Systemic: Inhalation 1
MAC: ACGIH (accepted); 400 milligrams per cubic meter of air.
Caution: May act as a simple asphyxiant. See also Cycloparaffins.
Fire Hazard: Dangerous; when exposed to heat or flame; it can react with oxidizing materials.
Spontaneous Heating: No
Underwriters Laboratory Classification: 90 - 95
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, in the form of vapor when exposed to flame (Section 7).
Explosive Range: 1.3 - 8.35%
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Inflammable liquid; red label.
  MCA warning label.

CYCLOHEXANOL

Synonyms: Hexahydrophenol.
Description: Colorless needles or viscous liquid; hygroscopic; camphor-like odor.
Formula: $C_6H_{11}OH$
Constants:
  Mol. Wt. 100.16
  M. P. -9°C (sets to a glass)
  B. P. 161.5°C
  Flash P. 154°F (C.C.)
  Density 0.9449 @25°/4°C
  Vap. Press. 1 mm @21.0°C
  Vap. D. 3.45
Toxic Hazard Rating:
  Acute Local: Irritant 1; Inhalation 1
  Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 1
  Chronic Local: Irritant 1; Ingestion 1; Inhalation 1
  Chronic Systemic: U
MAC: ACGIH (accepted); 409 milligrams per cubic meter of air; 100 parts per million in air.
Fire Hazard: Moderate; when

exposed to heat or flame; it can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
MCA warning label.

CYCLOHEXANOL ACETATE

Description: Pale-yellow liquid.
Formula: $C_6H_{11}OOCCH_3$
Constants:
  Mol. Wt. 142.19
  B. P. 177°C
  Density 0.996
  Vap. D. 4.9
Toxicity: Details unknown. See Cycloparaffins.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

CYCLOHEXANONE

Synonym: Ketohexamethylene; pimelic ketone.
Description: Colorless liquid, acetone-like odor.
Formula: $CO(CH_2)_4CH_2$
Constants:
  Mol. Wt. 98.14
  M. P. −45.0°C
  B. P. 155.6°C
  Flash P. 147°F (C.C.)
  Density 0.9478 @20°/4°C
  Autoign. Temp. 847°F
  Vap. Press. 10 mm @38.7°C
Toxic Hazard Rating:
  Acute Local: Irritant 2
  Acute Systemic: Ingestion 1; Inhalation 1
  Chronic Local: Irritant 1
  Chronic Systemic: Ingestion 1
Toxicology: Experimentally, animals exposed to 0.4% of cyclohexanone may be killed after prolonged exposure. The oral M.L.D. for rabbits is between 1.0 and 1.6 grams per kilogram. In man, 50 ppm can cause irritation of the eyes and throat. Mild narcotic properties have also been described. See also Cycloparaffins.
MAC: ACGIH (accepted); 100 parts per million in air; 401 mg/m^3 of air.
Fire Hazard: Moderate, when exposed to heat or flame; can react vigorously with oxidizing materials.
Underwriters Laboratory Classification: 35 - 40
Spontaneous Heating: No
To Fight Fire: Dry chemical, carbon tetrachloride or carbon dioxide.
Explosion Hazard: Slight, in its vapor form, when exposed to flame.
Explosive Range: 1.1% at 212°F (L.E.L.)
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
MCA warning label.

CYCLOHEXANONE-Δ

Description: Liquid.
Formula: C_6H_8O
Constants:
  Mol. Wt. 96.12
  B. P. 155.5°C
  Flash P. 93°F (C.C.)
  Vap. D. 3.31
  Vap. Press. 4 mm @20°C
Toxicity: Details unknown. Can cause a dermatitis upon skin contact (Section 9). Irritating to eyes, skin and mucous membranes. Can damage the liver and kidneys. See also Cycloparaffins.
Fire Hazard: Moderate, when exposed to flame and heat; it can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use moderate rate).
Shipping Regulations: Section 11.
  MCA warning label.

CYCLOHEXENE

Synonym: 1,2,3,4-Tetrahydrobenzene.
Description: Colorless liquid.
Formula: $\underline{CH_2CH_2CH_2CH_2CHCH}$
Constants:
  Mol. Wt. 82.14
  B. P. 83°C
  Freezing P. −103.7°C
  Flash P. −21°F

Density 0.8102 @20°/4°C
Vap. Press. 160 mm @38°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Inhalation 2
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (accepted); 400 milligrams per cubic meter of air.
Fire Hazard: Dangerous, when exposed to flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous! Keep away from heat and open flame!
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

CYCLOHEXENE OXIDE

Description: Clear liquid.
Formula: $C_6H_{10}O$
Constants: Mol. Wt. 98.14
B. P. 129.5°C; Flash P. 81°F
Density 0.9678 @25°/4°C
Vap. D. 3.5
Toxicity: Details unknown.
Fire Hazard: Dangerous, when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7

CYCLOHEXYL ACETATE

Synonym: Hexalin acetate.
Formula: $CH_3COOC_6H_{11}$
Constants:
Mol. Wt. 142.19
B. P. 350°F
Flash P. 136°F
Vap. D. 4.9
Toxicity: Details unknown. See Cyclohexyl Alcohol and Acetic Acid.
Fire Hazard: Moderate, when exposed to flame; it can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

CYCLOHEXYL ALCOHOL. See Cyclohexanol.

CYCLOHEXYLAMINE

Synonyms: Hexahydroaniline; aminocyclohexane.
Description: Liquid, strong fishy odor.
Formula: $C_6H_{13}N$
Constants:
Mol. Wt. 99.2
M. P. -17.7°C
B. P. 134.5°C
Flash P. 90°F (O.C.)
Density 0.865 @25°/25°C
Autoign. Temp. 500°F
Vap. D. 3.42
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Irritant 2
Chronic Systemic: Ingestion 2; Inhalation 2
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; it can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

N-CYCLOHEXYL-2-BENZOTHIAZOLE SULFENAMIDE

Description: Light tan or buff powder.
Formula: $C_6H_4NSCSNHC_6H_{11}$
Constants:
Mol. Wt. 264.4
M. P. 94°C
Density 1.27 @25°C
Toxicity: Details unknown.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

CYCLOHEXYL CHLORIDE

Description: Clear liquid.
Formula: $C_6H_{11}Cl$
Constants: Mol. Wt. 118.61
M. P. -43°C
B. P. 142°C

Flash P. 89°F
Density 0.9923 @25°/4°C
Vap. D. 4.0
Toxicity: See Chlorides.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Ventilation Control (use moderate rate).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; it can react with oxidizing materials.
Storage and Handling: Section 7

2-CYCLOHEXYL CYCLOHEXANOL

Description: Colorless liquid.
Formula: $C_6H_{11}C_6H_{10}OH$
Constants:
Mol. Wt. 182.3
B. P. 271 - 277°C
Flash P. 255°F
Density 0.977 @25°/25°C
Toxicity: See Alcohols.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemicals or carbon tetrachloride (Section 6).
Storage and Handling: Section 7.

2-CYCLOHEXYL-4,6-DINITROPHENOL

Description: Crystals.
Formula: $C_6H_{11}C_6H_2OH(NO_2)_2$
Constant:
Mol. Wt. 266.23
Toxicity: See Dinitrophenol.
Fire Hazard: See Nitrates.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; it can react vigorously with oxidizing materials.
Storage and Handling: Section 7

o-CYCLOHEXYL PHENOL

Description: Nearly white crystals.
Formula: $C_6H_{11}C_6H_4OH$
Constants:
Mol. Wt. 176.2
M. P. 50°C
B. P. 169°C @25 mm
Flash P. 270°F
Density 1.018 @60°/25°C
Toxicity: Details unknown. See Phenol.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

N-CYCLOHEXYL-p-TOLUENE SULFONAMIDE

Description: Fine white crystals.
Formula: $CH_3C_6H_4SO_2NHC_6H_{11}$
Constants:
Mol. Wt. 253
M. P. 86°F
B. P. 350°C
Density 1.125
Toxicity: Details unknown.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

CYCLOHEXYLTRICHLOROSILANE

Formula: $C_6H_{11}SiCl_3$
Constants:
Mol. Wt. 218.6
B. P. 208°C
Flash P. 196°F (O.C.)
Density 1.2
Vap. D. 7.5
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition or on contact with water or steam, it emits toxic and corrosive fumes.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Corrosive liquid; white label.

CYCLOOCTATETRAENE

Description: Liquid.
Formula: C_8H_8
Constants:
Mol. Wt. 104.14
M. P. -4.7°C
B. P. 140.6°C
Freezing P. -4.7°C
Vap. Press. 7.9 mm @25°C
Toxicity: Details unknown. May be

a simple asphyxiant.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
Storage and Handling: Section 7

CYCLOPARAFFINS
Toxicology: Both the saturated and unsaturated members of the cycloparaffin series are narcotic, and may cause death through respiratory paralysis. For most of the members there appears to be little range between the concentrations causing deep narcosis and those causing death. There is very little information in the literature regarding the chronic effects resulting from exposure of humans to the cycloparrafins. Experimental work with rabbits indicate that barely demonstrable changes in the liver and kidneys may result from exposure to 786 ppm of cyclohexane for 6 hours daily, repeated for 50 days.
Ventilation Control (use normal rate): Section 2

CYCLOPENTADIENE-1,3
Description: Colorless liquid.
Formula: C_5H_6
Constants:
Mol. Wt. 66.1
M. P. -85°C
B. P. 42.5°C
Density 0,80475 @19°/4°C
Toxicity: Details unknown. An insecticide and fungicide.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Explosion Hazard: Moderate, in the form of gas when exposed to heat or by chemical reaction. It decomposes violently at high temperatures and pressures (Section 7).
Storage and Handling: Section 7

CYCLOPENTANE
Synonym: Pentamethylene.
Description: Colorless liquid.
Formula: $(CH_2)_5$
Constants:
Mol. Wt. 70.08
B. P. 49.3°C
Freezing P. -93.7°C
Flash P. < 20°F
Density 0.745 @20°/4°C
Vap. Press. 400 mm @31.0°C
Vap. D. 2.42
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous! Keep away from heat and open flame!
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

CYCLOPENTANOL
Description: Clear liquid.
Formula: C_5H_8OH
Constants:
Mol. Wt. 86.13
B. P. 139.5°C
Flash P. 124°F
Density 0.9422 @25°/4°C
Toxicity: Details unknown
Fire Hazard: Moderate, in the presence of heat or flame; it can react with oxidizing materials.
Storage and Handling: Section 7

CYCLOPENTANONE
Synonyms: Dumasin; ketocyclopentane.
Description: Liquid.
Formula: C_5H_8O
Constants:
Mol. Wt. 84.1
M. P. -58.2°C
B. P. 130.6°C
Flash P. 87°F
Density 0.9509 @18°/4°C
Toxicity: See Cycloparaffins.
Fire Hazard: Moderate, when exposed to flame; it can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

CYCLOPENTANONE OXIME

Description: Solid.
Formula: C_5H_8NOH
Constants:
Mol. Wt. 99.13
M. P. 57.5°C
Toxicity: Unknown
Fire Hazard: Slight; on decomposition it can emit toxic fumes.
Storage and Handling: Section 7

CYCLOPENTENE

Description: Liquid.
Formula: C_5H_8
Constants: Mol. Wt. 68.1
M. P. -93.3°C
B. P. 44.242°C
Freezing P. -135.2°C
Flash P. -20°F
Density 0.77199 @20°C
Toxicity: See Cycloparaffins.
Fire Hazard: Dangerous, when exposed to flame or heat; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous! Keep away from heat and open flame!
Ventilation Control (use moderate rate).

CYCLOPENTYL BROMIDE

Description: Liquid.
Formula: C_5H_9Br
Constants:
Mol. Wt. 149.04
B. P. 137.5°C
Flash P. 108°F
Density 1.3866 @25°/4°C
Vap. D. 5
Toxicity: See Bromides.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; it can react with oxidizing materials.
Storage and Handling: Section 7

CYCLOPENTYL CHLORIDE

Description: Liquid.
Formula: C_5H_9Cl
Constants:
Mol. Wt. 104.58
B. P. 113.5°C
Flash P. 60°F
Density 1.0024 @25°/4°C
Vap. D. 3.5
Toxicity: See Chlorides.
Fire Hazard: Dangerous; when exposed to heat or flame (Section 6).
Explosion Hazard: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; it can react with oxidizing materials.
Ventilation Control (use moderate rate).

CYCLOPROPANE

Synonym: Trimethylene.
Description: Colorless gas.
Formula: $CH_2CH_2CH_2$
Constants:
Mol. Wt. 42.08
M. P. -126.6°C
B. P. -33.5°C
Density 1.879 g/l @0°C
Autoign Temp. 928°F
Vap. D. 1.45
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Inhalation 2
Chronic Local: 0
Chronic Systemic: U
MAC: ACGIH (accepted); 400 parts per million in air; 688 milligrams per cubic meter of air.
Fire Hazard: Dangerous, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or water spray (Section 6).
Explosion Hazard: Moderate, in the form of vapor when exposed to heat or flame (Section 7).
Explosive Range 2.4 - 10.4%
Disaster Control: Dangerous! Keep away from heat and open flame!
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable gas; red gas label.
Coast Guard Classification: Inflammable gas; red gas label.

CYCLOPROPYL ETHYL ETHER

Description: Liquid.
Formula: $C_3H_5OC_2H_5$

Constants:
Mol. Wt. 86.1
Toxicity: See Ethers.
Fire Hazard: See Ethers.
Disaster Control: See Ethers.
Storage and Handling: Section 7

CYCLOPROPYL METHYL ETHER
Synonym: Cypronic ether.
Description: Liquid.
Formula: $C_3H_5OCH_3$
Constants:
Mol. Wt. 72.1
M. P. -119°C
B. P. 44.7°C
Density 0.786 @25°/4°C
Toxicity: See Ethers.
Fire Hazard: See Ethers.
Explosion Hazard: See Ethers.
Disaster Control: See Ethers.
Storage and Handling: Section 7

CYCLOPROPYL PROPYL ETHER
Description: Liquid.
Formula: $C_3H_5OC_3H_7$
Constant:
Mol. Wt. 100.2
Toxicity: See Ethers.
Fire Hazard: See Ethers.
Disaster Control: See Ethers.
Storage and Handling: Section 7

CYCLOTRIMETHYLENE TRINITRAMINE
Synonyms: RDX; cyclonite; hexogen.
Description: White, crystalling powder.
Formula: $C_3H_6N_6O_6$
Constants:
Mol. Wt. 222.15
M. P. 202°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

CYLINDERS, EMPTY
Shipping Regulations: Section 11.
I. C. C. Classification: See Section 11, §73.29.
Coast Guard Classification: Hazardous article.

p-CYMENE
Synonym: Isopropyl toluene.
Description: Liquid.
Formula: $CH_3C_6H_4CH(CH_3)_2$
Constants:
Mol. Wt. 134.21
M. P. -68.2°C
B. P. 176°C
Flash P. 117°F (C. C.)
Density 0.86
Autoign. Temp. 921°F
Vap. D. 4.62
Vap. Press. 1 mm @17.3°C
Toxicity: See Toluene.
Fire Hazard: Moderate, when exposed to heat or flame.
Spontaneous Heating: No
Underwriters Laboratory Classification: 30 - 35
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Slight, in the form of vapor (Section 7).
Explosive Range 0.7% @212°F (L. E. L.)
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; it can react with oxidizing materials.
Storage and Handling: Section 7

CYMOGENE. See Butane.

CYTISUS
Description: A wood dust.
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: Slight, when exposed to flame (Section 7).
Personal Hygiene: Section 3

D

2,4-D. See 2,4-Dichlorophenoxyacetic Acid.

"DC 200 FLUID"
Synonym: Hexamethyl disiloxane.
Description: Viscous liquid.
Formula: $(CH_3)_3Si\text{-}O\text{-}Si(CH_3)_3$
Constants:
  Mol. Wt. 162.4
  Vap. D. 5.5
Toxic Hazard Rating:
  Acute Local: Ingestion 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

DDD
Synonym: 2,2-bis-(p-Chlorophenyl)-1,1 dichloroethane.
Description: Crystalline solid.
Formula: $(ClC_6H_4)_2HCCHCl_2$
Constants:
  Mol. Wt. 320.1
  M. P. 110°C
  Vap. D. 11
Toxic Hazard Rating:
  Acute Local: Ingestion 2
  Acute Systemic: Ingestion 2; Inhalation 1
  Chronic Local: U
  Chronic Systemic: Ingestion 1; Inhalation 1
Toxicology: Insecticide similar in action to DDT but considered less toxic to mammals. See also DDT.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DDT
Synonym: Dichloro-diphenyl-trichloroethane; chlorophenothane, dicophane, 1,1,1-trichloro-2-2-bis(para-chlorophenyl) ethane.
Description: Colorless crystals or white to slightly off-white powder. Odorless or with slight aromatic odor.
Formula: $(ClC_6H_4)_2CHCCl_3$
Constants:
  Mol. Wt. 354.5
  M. P. 108.5 - 109°C
Toxicology: DDT is readily absorbed from the intestinal tract and, if it occurs in the air in the form of an aerosol or dust, it may be taken into the lung and readily absorbed. DDT is not, however, absorbed from the skin unless it is in solution. Solutions are absorbed from the skin and, by the same token, emulsions are absorbed to some extent. Likewise, fats and oils from whatever source increase the absorption of DDT from the intestine. DDT acts on the central nervous system, but the exact mechanism of this action either in man or in animals has not been elucidated. Large doses of DDT also induce nausea and/or diarrhea in man; however, whether this is a central or local action is not yet clear. Chronically, DDT produces microscopic changes in the liver and kidneys in some experimental animals. This has not been demonstrated in man. DDT is secreted in the milk and, as an acid derivative, is excreted in the urine of rabbits, dogs and man. DDT and certain of its degradation products, particularly DDE, are stored in fat. Such storage results either from a single large dose or from repeated small doses. DDT stored in the fat is at least largely inactive since a greater total dose may be stored in an experimental animal than is sufficient as a lethal dose for that same animal if given

at one time. A study based on 75 human cases reported an average of 5.3 ppm ot DDT stored in the fat. A higher content of DDT and its derivatives (up to 434 ppm of DDE and 648 ppm of DDT) was found in workers who had very extensive exposure. Without exception, the samples were taken from persons who were either asymptomatic or suffering from some disease completely unrelated to DDT. Careful hospital examination of workers who had been very extensively exposed and who had volunteered for examination revealed no abnormality which could be attributed to DDT. Much higher levels than have been found in man have been observed in the fat of experimental animals which were apparently asymptomatic. DDT stored in the fat is eliminated only very gradually when further dosage is discontinued. After a single dose, the secretion of DDT in the milk and its excretion in the urine reach their height within a day or two and continue at a lower level thereafter.

Dangerous Acute Dose in Man: A dose of 20 g has proved highly dangerous though not fatal to man. This dose was taken by five persons who vomited an unknown portion of the material and even so recovered only incompletely after 5 weeks. Smaller doses produced less important symptoms with relatively rapid recovery. Experimental ingestion of 1.5 g resulted in great discomfort and moderate neurological changes including paraesthesia, tremor, moderate ataxia, exaggeration of part of the reflexes, headache, and fatigue. Vomiting followed only after 11 hours. Recovery was complete on the following day. The fatal dose of DDT for man is not known. Judging from the literature, no one has ever been killed by DDT in the absence of other insecticides and/or a variety of toxic solvents. However, these common solvent formulations are highly fatal when taken in small doses, partly because of the toxicity of the solvent, and perhaps because of the increased absorbability of the DDT; several fatal cases in man have been reported.

Dangerous Chronic Dose in Man. Even less is known of the hazard of chronic DDT poisoning. It is known that certain experimental animals fed diets containing one part of DDT per million store the compound in their fat. The storage of DDT in man has been mentioned above. The exact significance of these findings is not known and their further investigation is of the greatest importance. The consistent lack of any demonstrable pathology in those occasional cases where high levels of DDT are present in fat would suggest that chronic exposure to low DDT residues on food would not be likely to lead to tissue damage.

Signs and Symptoms of Poisoning in Man. In patients who ate substantial doses of DDT in flour, the symptoms observed were vomiting, numbness and partial paralysis of the extremities, mild convulsions, loss of proprioception and vibratory sensation of the extremities, and hyperactive knee jerk reflexed. Symptoms appeared in 30 to 60 minutes after eating the DDT. The paralysis and numbness were most evident in the most distal portions of the extremities, and their intensity was directly proportional to the amount of DDT ingested. All the patients were apprehensive and excited; respiration was moderately rapid; pulse remained slow to normal. The immediate protective mechanism in man, following substantial doses, is vomiting. With smaller doses, nausea and vomiting are less prominent, but diarrhea has been observed. Signs and symptoms of chronic poisoning in man are unknown, although, judging from the observed microscopic changes in experimental animals, liver and kidney dysfunctions should be looked for. The primary irritancy of DDT is practically nil, and it has little or no tendency to produce allergy.

For detailed discussion of Toxicology, see Section 1

Dermatitis induced by DDT has occasionally been reported, but these reports are unconfirmed; nevertheless, the phenomenon should be expected to occur in rare instances (Section 9).

Laboratory Findings: Laboratory findings are essentially negative except for the presence of DDT which may be quantitatively measured by special methods.

Treatment of Poisoning: Depending on the condition of the patient, attention should first be given to the sedation or to the removal of poison which may have been taken internally. Stomach lavage and saline laxatives may be used. Oil laxatives should be avoided; they promote absorption of DDT and of many organic solvents. The five drugs of choice, arranged roughly in order of their effectiveness, are phenobarbital, pentobarbital, paraldehyde, urethane, and calcium gluconate. Phenobarbital, which has been used in doses up to 0.7 g per day in epilepsy, and pentobarbital (0.25 to 0.5 g) are the barbiturates known to control convulsions of central origin. Paraldehyde (average dosage 15 cc orally, 1 cc undiluted intravenously, 35 cc rectally in normal saline) controls the convulsions of DDT-poisoned animals. Urethane (human dosage 1 to 4g) has proved very effective in rats, but it should be remembered that the hypnotic and narcotic effects of urethane are not correspondingly high in man. Urethane has an added advantage, however, of being tolerated in the young and the aged. The object of sedation is not to induce sleep but to restore a relative calm; however, the proper dosage in the presence of poisoning may be so large that it would induce anesthesia if poisoning were not present.

Calcium gluconate has been used less than the other antidotes, but it is reported to control DDT-induced convulsions in several animals. Since its mechanism of action is entirely different, it may be used in addition to sedatives. Epinephrine is contraindicated.

DECABORANE

Synonyms: Boron hydride; decaboron tetradecahydride.
Description: Colorless needles.
Formula: $B_{10}H_{14}$
Constants:
  Mol. Wt. 122.3
  M. P. 99.7°C
  B. P. 213°C
  Density 0.94 (solid): 0.78 (liquid @100°C)
  Vap. Press. 19 mm @100°C
Toxicity: See Boron Compounds.
Fire Hazard: Unknown
Explosion Hazard: Moderate, when exposed to heat (Section 7).
Explosive Range: In oxygen @100°C.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of boron compounds and may explode; it can react with oxidizing materials.
Storage and Handling: Section 7

"DECALIN"

Synonym: Decahydronaphthalene.
Description: Water-white liquid.
Formula: $C_{10}H_{18}$
Constants: Mol. Wt. 138.3
  M. P. cis: -43.3°C
    trans: -30.7°C
  B. P. 195°C (cis: 194.6°C (trans: 186.7°C)
  Flash P. 136°F (C.C.)
  Autoign. Temp. 504°F
  Vap. Press. (cis: 1 mm @22.5°C) (trans: 10 mm @47.2°C)
  Density 0.8963; Vap. D. 4.76
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1
  Acute Systemic: Ingestion 1
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

DECANE

Synonym: Decyl hydride.
Description: Liquid.
Formula: $CH_3(CH_2)_8CH_3$
Constants:
  Mol. Wt. 142.3
  M. P. -29.7°C
  B. P. 174.1°C
  Flash P. 115°F (C.C.)
  Density 0.730 @20°/4°C
  Autoign. Temp. 482°F
  Vap. Press. 1 mm @16.5°C
  Vap. D. 4.90
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Inhalation 1
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Fozm, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, in its vapor form.
Explosive Range: 0.67 - 2.6%
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

1-DECENE

Synonym: n-Decylene.
Description: Colorless liquid.
Formula: $H_2CCH(CH_2)_7CH_3$
Constants:
  Mol. Wt. 140.26
  M. P. -66.3°C
  B. P. 172°C
  Density 0.7396 @20°/4°C
  Vap. Press. 1 mm @95.7°C
  Vap. D. 4.83
Toxicity: Unknown
Fire Hazard: Moderate; when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7

n-DECYL ALCOHOL

Synonym: 1-Decanol; nonyl carbinol.
Description: Viscous, refractive liquid.
Formula: $CH_3(CH_2)_8CH_2OH$
Constants:
  Mol. Wt. 158.3
  M. P. 7°C
  B. P. 231.0°C
  Flash P. 180°F
  Density 0.8297 @20°/4°C
  Vap. Press. 1 mm @69.5°C
  Vap. D. 5.3
Toxicity: Details unknown. See also Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DECYLAMINE

Description: Liquid.
Formula: $CH_3(CH_2)_9NH_2$
Constants:
  Mol. Wt. 157.3
  M. P. 17°C
  B. P. 95°C @10 mm
  Flash P. 210°F
  Density 0.79 @20°C
  Vap. D. 5.5
Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DECYL NAPHTHALENE

Description: Liquid.
Formula: $C_{10}H_{21}C_{10}H_7$
Constants:
  Mol. Wt. 268.5
  B. P. 330 - 440°C
  Flash P. 365°F
  Density 1.0
  Vap. D. 9.6
Toxicity: Details unknown. See also Naphthalene.
Fire Hazard: Slight; when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DEGUELEN

Description: Pale-green crystals.

Formula: $C_{23}H_{22}O_6$
Constants:
Mol. Wt. 394.41
M. P. 171°C
Toxicity: Details unknown; an insecticide of plant origin.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

DEHYDROABIETYLAMINE

Description: Amber, viscous liquid.
Formula: $C_{20}H_{25}N$
Constants:
Mol. Wt. 279.4
B. P. 344°C Decomposes
Flash P. 375°F (O. C.)
Density 1.001 @25°/15.6°C
Autoign. Temp. 430°F
Vap. D. 10
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DEHYDROABIETYLAMINE ACETATE

Description: Amber paste or solution.
Formula: $C_{20}H_{25}NCH_3COO$
Constants:
Mol. Wt. 338.5
Density 1.029 @25°/15.6°C
Vap. D. 11.5
Toxicity: Unknown
Fire Hazard: Slight; on decomposition it emits toxic fumes.
Storage and Handling: Section 7

DEHYDROABIETYLAMINE NAPHTHENATE

Description: Viscous liquid.
Formula: $C_{20}H_{25}NOOCC_6H_5$
Constant:
Mol. Wt. 406.6
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

DEHYDROABIETYLAMINE PENTACHLOROPHENATE

Description: Crystals.
Formula: $C_{20}H_{25}NC_6Cl_5$
Constants:
Mol. Wt. 528.8
Vap. D. 18
Toxicity: Details unknown. See also Pentachlorophenol.
Disaster Control: Dangerous; when heated, to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

DEHYDROABIETYL NITRILE

Description: Light amber, partially cyrstallized solid.
Toxicity: Highly toxic. See Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

DEHYDROACETIC ACID

Synonyms: 3-Acetyl-6 methyl-1, 2-pyran-2, 4(3H)-dione.
Description: Powder.
Formula: $C_8H_8O_4$
Constants:
Mol. Wt. 168.2
M. P. 109°C
B. P. 269.0°C
Vap. Press. 1 mm @91.7°C
Vap. D. 5.8
Toxicity: Details unknown; a fungicide and bactericide.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

DEKANITROCELLULOSE. See Nitrocellulose.

DELAY ELECTRIC IGNITERS. See Explosives, High.

DELPHININE

Description: White, crystalline, rhombic plates.
Formula: $C_{34}H_{47}NO_9$
Constants:
Mol. Wt. 613.73

M. P. 191°C Decomposes
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Caution: An alkaloid poison.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DELPHINIUM

Synonym: Larkspur; stagger weed.
Description: Dried ripe seeds.
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Irritant 2; Allergen 1
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes and it can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DEMETON

Synonyms: O, O-Diethyl-O, 2-(ethylthio) ethyl thiophosphate.

Hazardous Properties: It is believed that most of the physiological actions of demeton resemble, generally, those of parathion, TEPP, and other related organic phosphorus poisons. The actions of this compound and its metabolites are based principally upon the inhibition of the enxyme cholinesterase, thus allowing the accumulation of large amounts of acetylcholine.

Dangerous Acute and Chronic Doses: Little is known regarding the acute and chronic dosages which would be dangerous to man. However, the acute dose is believed to be approximately equal to that of parathion (estimated at from 12 to 20 mg or one-fifth to one-third grain). The compound is only slightly less toxic by the dermal route. Doses of organic phosphorus insecticides tend to be cumulative in their effect. However, if illness occurs, it is acute in nature, whether caused by a single large dose or by repeated exposure.

Signs and Symptoms of Poisoning: Persons poisoned with demeton may be expected to show the following symptoms: Headache, giddiness, blurred vision, weakness, nausea, diarrhea, and discomfort in the chest. In addition to these symptoms, sweating, miosis, muscular fasciculation, incoordination, tearing, salivation, pulmonary edema, cyanosis, papilledema, convulsions, coma, and loss of reflexes and sphincter control may occur. There is one result of demeton poisoning in rats which may or may not be peculiar to the species. Shortly after other signs of poisoning appeared, rats fed 50 or 100 ppm of demeton in their regular diet developed severe exophtalmos, and perhaps associated changes, leading to drying and ulceration of the cornea so severe that some animals lost both eyes through necrosis.

Treatment of Poisoning: Keep the patient fully atropinized, using 1 to 2 mg of atropine sulfate per dose and up to 10 to 20 mg per day. Remove any remaining poison. Administer oxygen and other supportive measures early and be prepared for the immediate use of mechanical artificial respiration. Watch the patient continuously. See also Parathion.

DENATURANTS

Toxicity: These materials are almost always toxic. See also specific denaturant.

DENATURED ALCOHOL. Ethyl alcohol to which a toxic ingredient has been added (denaturant).

"DEPENDIP"
Description: Water-white liquid.
Constants:
  Flash P. 52°F
  Density 0.758 @15.5°C
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Inhalation 1
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame; it can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated, it emits acrid fumes.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

DETONATING FUSES. See Explosives, High.

DETONATING PRIMERS. See Explosives, High.

DEUTERIUM. See Hydrogen.

DFDD
Synonym: Difluorodiphenyldichloroethane.
Description: Crystals.
Formula: $C_{14}H_{10}Cl_2F_2$
Constants:
  Mol. Wt. 287.2
  M. P. 77.5°C
  Vap. D. 10
Toxicity: Details unknown; a contact insecticide.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides and chlorides.
Storage and Handling: Section 7

DFDT
Synonym: 2,2-bis-(p-Fluorophenyl)-1,1,1 trichloroethane.
Description: Crystals.
Formula: $(FC_6H_4)_2CHCCl_3$
Constants:
  Mol. Wt. 302.6
  M. P. 45.5°C
  Vap. D. 10.5
Toxicity: Details unknown; an insecticide.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides and chlorides.
Storage and Handling: Section 7

DIACETONE (ACETONE-FREE)
Synonym: 4-Hydroxy-4-methylpentanone-2.
Description: Liquid; faint pleasant odor.
Formula:
  $(CH_3)_2C(OH)CH_2COCH_3$
Constants:
  Mol. Wt. 116.2
  M. P. -47 to -54°C
  B. P. 167.9°C
  Flash P. 151°F
  Density 0.9306 @25°/4°C
  Autoign Temp. 1190°F
  Vap. D. 4.00
  Vap. Press. 1.1 mm @20°C
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Inhalation 1
  Chronic Local: Irritant 1
  Chronic Systemic: Inhalation 1
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventialation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIACETONE ALCOHOL (TECHNICAL)
Description: Liquid, pleasant odor.
Formula: $CH_3COCH_2C(CH_3)_2OH$
Constants:
  Mol. Wt. 116.2
  B. P. 163°C
  Flash P. 48°F (O. C.)
  Density 0.931 - 0.940
  Autoign. Temp. 1118°F
  Vap. Press. 1.1 mm @20°C
  Vap. D. 4.00
  Freezing P. -42.8°C
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 1
    Inhalation 1
  Chronic Local: Irritant 1
  Chronic Systemic: U

MAC: ACGIH (tentative); 50 parts per million in air. See also Alcohols.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; keep away from heat and open flame; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIACETYL
Synonym: Butanedione.
Description: Greenish-yellow liquid, strong odor.
Formula: $CH_3COCOCH_3$
Constants:
Mol. Wt. 86.09
B. P. 88°C
Flash P. < 80°F
Density 0.9904 @15°/15°C
Vap. D. 3.00
Toxicity: Details unknown.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous! Keep away from heat and open flame.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

DIACETYLENE
Synonyms: Butadiyne; butadiine.
Description: Gas.
Formula: HC⋮CC⋮CH
Constants:
Mol. Wt. 50.1
M. P. −36.4°C
B. P. 10.3°C
Density 2.233
Toxicity: Details unknown.
Fire Hazard: Moderate, when exposed to heat or flame, or by chemical reaction with oxidizers. Can ignite spontaneously in contact with moist silver salts.
Explosion Hazard: Unknown
Storage and Handling: Section 7

DIACETYLENE CARBONIC ACID
Toxicity: Unknown
Fire Hazard: Unknown
Explosion Hazard: Moderate, when exposed to heat at 367°F (Section 7).
Storage and Handling: Section 7

DIACETYL MORPHINE
Synonyms: Diamorphine; heroin.
Description: White, odorless, bitter, crystals or crystalline powder.
Formula: $C_{17}H_{17}(OOCCH_3)_2NO$
Constants:
Mol. Wt. 369.40
M. P. 171 - 173°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 2
Toxicology: Fatal dose between 1/6 and 2 grains. Resembles morphine in its general results, but acts more strongly on the respiration and is therefore more poisonous. Its depressant effects on the cerebrum appear to be greater than that of codeine. Large doses cause excitement and convulsions in animals and man. The more common symptoms are headache, disturbance of vision, slow, small regular pulse, restlessness, cramps in the extremities, slight cyanosis, respiration slow and deep, and death from respiratory paralysis. Poisonous habit-forming drug.
Treatment and Antidotes: Use the same treatment as for morphine, with special attention to control of the respiratory paralysis.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of oxides of nitrogen.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DIACETYLMORPHINE HYDROCHLORIDE. See Diacetyl Morphine.

DIALLYL CYANAMIDE
Description: Colorless, mobile liquid

when pure.
Formula: $(CH_2CHCH_2)_2NCN$
Constants:
Mol. Wt. 122.17
M. P. < −70°C
B. P. 222°C (slight decomp.)
Density 0.9021
Vap. D. 4.1
Toxicity: Highly toxic. See Cyanides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DIALLYL ETHYLENE BIS-GLYCOLATE

Description: Liquid.
Formula: $(CH_2OCH_2CO_2CH_2CHCH_2)_2$
Constants:
Mol. Wt. 258.3
B. P. 130 - 133°C @1 mm
Flash P. 320°F (O.C.)
Density 1.1227 @25°/25°C
Vap. D. 8.9
Toxicity: Details unknown
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIALLYL MALEATE

Synonym: Allyl maleate.
Description: Liquid.
Formula: $(CHCOOCH_2CHCH_2)_2$
Constants:
Mol. Wt. 196.2
Vap. D. 6.6
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: Ingestion 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIALLYL MELAMINE

Description: White, crystalline solid.
Formula: $(CH_2CHCH_2)_2N(CN)_3(NH_2)_2$
Constants:
Mol. Wt. 226.3
M. P. 142°C
Density 1.242 @30°C
Vap. D. 7.6
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIALLYL PHTHALATE

Description: Nearly colorless, oily liquid.
Formula: $C_6H_4(CO_2CH_2CHCH_2)_2$
Constants: Mol. Wt. 246.3
B. P. 157°C
Flash P. 330°F
Density 1.120 @20°/20°C
Vap. D. 8.3
Toxicity: See Phthalic Acid.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIALLYL SULFIDE

Synonym: Allyl sulfide.
Description: Colorless liquid, garlic odor.
Formula: $(CH_2CHCH_2)_2S$
Constants:
Mol. Wt. 114.2
M. P. −83°C
B. P. 139°C
Density 0.888 @27°/4°C
Vap. D. 3.93
Toxicity: Details unknown.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when

heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

1, 3-DIAMINOBUTANE

Description: Liquid.
Formula: $C_4H_8(NH_2)_2$
Constants:
  Mol. Wt. 88.2
  B. P. 142 - 150°C
  Flash P. 125°F
  Density 0.85
  Vap. D. 3.04
Toxicity: Details unknown.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

DIAMINODIPHENYL SULFONE (TECHNICAL)

Description: A free-flowing, light-brown powder.
Formula: $C_{12}H_{12}O_2N_2S$
Constants:
  Mol. Wt. 248.3
  M. P. 165 - 170°C
  Vap. D. 8.3
Toxicity: Details unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

1, 3-DIAMINOPROPANE

Description: Liquid.
Formula: $C_3H_6(NH_2)_2$
Constants:
  Mol. Wt. 74.1
  B. P. 133°C
  Flash P. 75°F
  Density 0.88
  Vap. D. 2.5
Toxicity: Details unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous! Keep away from heat and open flame!
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

2, 6-DIAMINOPYRIDINE

Description: Crystals.
Formula: $NC_5H_3(NH_2)_2$
Constants:
  Mol. Wt. 109.08
  M. P. 120.8°C
  B. P. 285°C
Toxicity: Details unknown. See also Pyridine.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of nitrogen compounds.
Storage and Handling: Section 7

DIAMMINECOBALT (II) CHLORIDE

Description: Rose crystals.
Formula: $CoCl_2 \cdot 2NH_3$
Constants:
  Mol. Wt. 163.92
  M. P. 273°C
  Density 2.097
Toxicity: See Cobalt Compounds.
Fire Hazard: Slight, when heated and exposed to flame because of the ammonia evolved (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of ammonia and chlorides.
Storage and Handling: Section 7

DIAMMINECOPPER (II) ACETATE

Description: Violet-blue crystals.
Formula: $Cu(C_2H_3O_2)_2 \cdot 2NH_3$
Constants:
  Mol. Wt. 215.69
  M. P. Decomp. @approx. 175°C
Toxicity: See Copper Compounds.
Fire Hazard: Slightly dangerous; when heated, it emits acrid fumes.
Storage and Handling: Section 7

DIAMYL ACETAMIDE

Description: Liquid.
Formula: $(C_5H_{11})_2CHCONH_2$
Constants:
  Mol. Wt. 199.3
  Flash P. 235°F
  Vap. D. 6.7
Toxicity: Details unknown
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIAMYLAMINE

Synonym: Di-n-amylamine.
Description: Water-white liquid.
Formula: $(C_5H_{11})_2NH$
Constants:
Mol. Wt. 157.26
B. P. 202°C @760 mm
Flash P. 150°F (O.C.)
Density 0.777 @20°/20°C
Vap. D. 5.42
Toxicity: See Amines.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

DIAMYL ANILINE

Description: Liquid.
Formula: $C_6H_5N(C_5H_{11})_2$
Constants:
Mol. Wt. 233.4
B. P. 277°C
Flash P. 260°F
Density 0.89
Vap. D. 7.8
Toxicity: Details unknown. See also Aniline.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes and it can react with oxidizing materials.
Storage and Handling: Section 7

DIAMYL BENZENE

Description: Liquid.
Formula: $C_6H_4(C_5H_{11})_2$
Constants:
Mol. Wt. 218.4
B. P. 265°C
Flash P. 225°F
Density 0.85
Vap. D. 7.3
Toxicity: Details unknown. See also Benzene.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIAMYL BIPHENYL

Description: Liquid.
Formula: $C_5H_{11}(C_6H_4)_2C_5H_{11}$
Constants:
Mol. Wt. 294.5
M. P. −30°C
Flash P. 340°F
B. P. 355 - 385°C
Density 0.938 @20°/20°C
Vap. D. 10.2
Toxicity: Details unknown.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIAMYL CHLORONAPHTHALENE

Description: Liquid.
Formula: $(C_5H_{11})_2C_{10}H_5Cl$
Constants:
Mol. Wt. 302.9
B. P. 350°C
Flash P. 330°F
Density 1.06
Vap. D. 10.4
Toxicity: Details unknown. See also Chloronaphthalenes.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; it can react vigorously with oxidizing materials.
Storage and Handling: Section 7

DIAMYLENE

Description: Liquid.
Formula: $C_{10}H_{20}$
Constants:
Mol. Wt. 140.26
M. P. Below −50°C
B. P. 150°C
Flash P. 118°F (O.C.)

Density 0.77 - 0.78
Vap. D. 4.7
Toxicity: Details unknown.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

DIAMYL MALEATE
Description: Liquid.
Formula: $(CHCO_2C_5H_{11})_2$
Constants: Mol. Wt. 256.3
Flash P. 270°F
Density 0.981
Vap. D. 8.6
Toxicity: Details unknown. See also Esters and Amyl Alcohol.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIAMYL NAPHTHALENE
Description: Liquid.
Formula: $C_{10}H_6(C_5H_{11})_2$
Constants: Mol. Wt. 268.43
B. P. 326°C
Flash P. 315°F (O.C.)
Density 0.93 - 0.94
Vap. D. 9.3
Vap. Press. 0.00124 @ 20°C
Toxicity: Details unknown. See also Naphthalene.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

DIAMYL beta-NAPHTHOL
Description: Liquid.
Formula: $(C_5H_{11})_2C_{10}H_5OH$
Constants: Mol. Wt. 284.4
B. P. 205°C
Flash P. 345°F
Density 0.97
Vap. D. 9.6
Toxicity: Details unknown. See also beta-Naphthol.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIAMYL OXALATE
Description: Liquid.
Formula: $(C_5H_{11}CO_2)_2$
Constants:
Mol. Wt. 230.3
Flash P. 257°F
Vap. D. 7.7
Toxicity: See Oxalates and Amyl Alcohol.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2,4-DIAMYL PHENOL
Description: Liquid.
Formula: $(C_5H_{11})_2C_6H_3OH$
Constants:
Mol. Wt. 234.37
B. P. 278°C
Flash P. 260°F (O.C.)
Density 0.93 - 0.94
Vap. D. 8.1
Toxicity: Details unknown. See also Phenol.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; it can react with oxidizing materials.
Storage and Handling: Section 7

DI-sec-AMYL PHENOL
Description: Liquid.
Formula: $(C_5H_{11})_2C_6H_3OH$
Constants:
Mol. Wt. 234.4
B. P. 280°C
Flash P. 260°F (O.C.)
Density 0.91
Vap. D. 8.1
Toxicity: Probably toxic. See also Phenol.
Fire Hazard: Slight, when exposed to heat or flame; it can react

with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DI-tert-AMYLPHENOXY ETHANOL
Description: Liquid.
Formula: $C_6H_3(C_5H_{11})_2OCH_2CH_2OH$
Constants: Mol. Wt. 278.4
M. P. -35°C
Flash P. 300°F (O.C.)
B. P. 321°C
Density 0.959
Vap. D. 9.6
Vap. Press. < 0.01 mm
Toxicity: Details unknown. See also Alcohols.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical, or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIAMYL PHTHALATE
Description: Liquid.
Formula: $C_6H_4(COOC_5H_{11})_2$
Constants:
Mol. Wt. 306.4
B. P. 333°C
Flash P. 357°F (C.C.)
Vap. D. 10.5
Toxicity: See Esters, Amyl Alcohol and Phthalic Acid.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DI-n-AMYL PHTHALATE
Synonym: Amyl phthalate.
Description: Liquid.
Formula: $C_6H_4(CO_2C_5H_{11})_2$
Constants:
Mol. Wt. 306.4
B. P. 243 - 255°C @ 50 mm
Flash P. 245°F (C.C.)
Density 1.023
Vap. D. 10.5
Toxicity: See Esters, Amyl Alcohol and Phthalic Acid.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIAMYL SODIUM SULFOSUCCINATE
Description: White, waxy solid.
Formula:
$C_5H_{11}CO_2CH_2\underline{CHCO_2C_5H_{11}S}O_3Na$
Constant:
Mol. Wt. 360
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: Irritant 1
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIAMYL SULFIDE. See Amyl Sulfide.

DIANISIDINE
Synonym: Dimethoxybenzidine.
Description: Liquid.
Formula: $[NH_2(OCH_3)C_6H_3]_2$
Constants:
Mol. Wt. 244.29
M. P. 137 - 138°C
Flash P. 403°F
Vap. D. 8.5
Toxicity: Details unknown. See also Benzidine.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2,2-DI-p-ANISYL-1,1,1-TRICHLOROETHANE
Formula:
$(CH_3OC_6H_4CO_2)_2C_2HCl_3$
Constants:
Mol. Wt. 433.7
M. P. 89°C
Vap. D. 15
Toxicity: Details unknown. An insecticide.

Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

DIATOMACEOUS EARTH
Synonyms: Infusorial earth; kieselguhr.
Description: A soft, earthy rock.
Formula:
SiO_2, K_2O, Al_2O_3, Fe_2O_3, CaO
Constant:
Density 0.24 - 0.34
Toxic Hazard Rating:
Acute Local: Inhalation 2
Acute Systemic: U
Chronic Local: Inhalation 2
Chronic Systemic: Inhalation 2
Toxicology: Diatomaceous earth dust may cause disabling fibrosis of the lungs, but it is less likely to do so than SiO_2 in the crystalline form.
Ventilation Control (use normal rate): Section 2

DIAZOACETIC ESTER
Synonyms: Ethyl diazoacetate; ethyl diazoethanoate.
Description: Yellow oil, pungent odor, very volatile.
Formula: $C_4H_6N_2O_2$
Constants:
Mol. Wt. 114.1
M. P. −22°C
B. P. 141°C @720 mm
Density 1.0852 @17.6°/4°C
Vap. D. 3.9
Toxicity: Details unknown. See also Esters.
Explosion Hazard: Moderate, when exposed to heat, upon contact with concentrated sulfuric acid, or upon distillation.
Disaster Control: Dangerous; explodes when heated; on contact with acid or acid fumes, it emits toxic fumes.
Storage and Handling: Section 7

alpha-DIAZOAMIDOBENZOL
Synonyms: Diazoaminobenzene; 1,3-diphenyltriazine.
Description: Golden yellow crystals.
Formula: $C_6H_5NNNHC_6H_5$
Constants:
Mol. Wt. 197.2
M. P. 98 - 99°C
B. P. Explodes
Vap. D. 6.8
Toxicity: Details unknown. An insecticide. See also Benzene.
Explosion Hazard: Severe, when shocked or exposed to heat (Section 7).
Disaster Control: Dangerous; shock or heat will explode it.
Storage and Handling: Section 7

beta-DIAZOAMIDOBENZOL
Synonym: Benzene diazoanilide.
Description: Yellow crystals.
Formula: $C_6H_5NNNHC_6H_5$
Constants: Mol. Wt. 197.2
M. P. 80 - 81°C
B. P. Explodes
Vap. D. 6.8
Toxicity: Details unknown. See also Benzene.
Explosion Hazard: Severe, when shocked or exposed to heat (Section 7).
Disaster Control: Dangerous; explodes when heated and emits toxic fumes.
Storage and Handling: Section 7

1,1'-DIAZOAMIDONAPHTHALENE
Synonym: 1,3-Di-1-naphthyltriazine.
Description: Yellow leaflets.
Formula: $C_{10}H_7NNNHC_{10}H_7$
Constants:
Mol. Wt. 297.4
M. P. Explodes @100°C
Vap. D. 10.25
Toxicity: Details unknown. See also Naphthalene.
Explosion Hazard: Severe, when shocked or exposed to heat.
Disaster Control: Dangerous; explodes when heated or shocked; emits toxic fumes.
Storage and Handling: Section 7

DIAZOAMINOBENZENE. See alpha-Diazoamidobenzol.

DIAZOBENZENE CHLORIDE
Synonym: Benzene diazonium chloride.
Description: Colorless needles.
Formula: $C_6H_5N(\vdots N)Cl$
Constants:
Mol. Wt. 140.6
M. P. Decomposes
B. P. Explodes
Vap. D. 4.9

Toxicity: Unknown
Explosion Hazard: Severe, when shocked or exposed to heat (Section 7).
Disaster Control: Dangerous; shock and heat will explode it; emits toxic fumes.
Storage and Handling: Section 7

DIAZOBENZENE NITRATE

Synonym: Benezene diazonium nitrate.
Description: Colorless needles.
Formula: $C_6H_5N(\vdots N)NO_3$
Constants:
Mol. Wt. 167.1
M. P. Explodes @90°C
Density 1.37 @20°/4°C
Vap. D. 5.8
Toxicity: Unknown
Fire Hazard: See Nitrates.
Explosion Hazard: Severe; explodes when slightly shocked or exposed to heat (Section 7). See also Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

p-DIAZOBENZENESULFONIC ACID

Synonym: Sulfanilic acid diazide.
Description: White paste (white or slightly red crystals).
Formula: $C_6H_4NSO_3N$
Constants:
Mol. Wt. 184.17
Vap. D. 6.3
Toxicity: Details unknown.
Explosion Hazard: Severe, when shocked, exposed to heat, or by chemical reaction (Section 7).
Disaster Control: Dangerous; shock and heat will explode it; emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

DIAZOBENZOIC NITRATE. See Diazobenzene nitrate.

DIAZOBENZOL ANILIDE. See Diazoamidobenzol.

DIAZOBENZOL CHLORIDE. See Diazobenzene Chloride.

DIAZOBENZOL CHROMATE

Synonym: Benzene diazonium chromate.
Description: Crystals.
Formula: $[C_6H_5N(\vdots N)]_2CrO_4$
Constant:
Mol. Wt. 326.3
Toxicity: See Chromium Compounds and Benzene.
Fire Hazard: See Chromates.
Explosion Hazard: Severe, when shocked or exposed to heat (Section 7).
Disaster Control: Dangerous; shock and heat will explode it; emits toxic fumes.
Storage and Handling: Section 7

DIAZOBENZOLIMIDE

Synonym: Diazobenzeneimide; tiazobenzene.
Description: Yellow oil.
Formula: $C_6H_5N_3$
Constants:
Mol. Wt. 119.1
B. P. 59°C @12 mm (explodes)
Density 1.078 @22.5°C
Vap. D. 6.6
Toxic Hazard: Details unknown
Fire Hazard: Unknown
Explosion Hazard: Severe, when shocked or exposed to heat (Section 7).
Disaster Control: Dangerous; shock and heat will explode it; emits toxic fumes and it can react with oxidizing materials.
Storage and Handling: Section 7

DIAZOBENZOL NITRATE. See Diazobenzene Nitrate.

DIAZOBENZOL SULFATE

Synonym: Diazobenzene sulfate.
Description: Crystals.
Formula: $[C_6H_5N(\vdots N)]_2SO_4$
Constants:
Mol. Wt. 306.3
M. P. Explodes @100°C
Vap. D. 10.6
Toxicity: Details unknown.
Explosion Hazard: Severe, when shocked or exposed to heat (Section 7).
Disaster Control: Dangerous; shock and heat will explode it; it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

DIAZOBENZOLSULFONIC ACID See p-Diazobenzenesulfonic acid.

DIAZODINITROPHENOL

Synonym: Dinol.
Description: Crystals.
Formula: $HOC_6H_3(NO_2)_2N(\vdots N)$
Constants:
Mol. Wt. 212.1
M. P. Explodes @180°C
Density 1.63
Vap. D. 7.3
Toxicity: Unknown
Fire Hazard: See Nitrates.
Explosion Hazard: Severe; when shocked or exposed to heat or friction. A less sensitive high explosive to impact than lead azide or mercury fulminate. It is a powerful initiator (Section 7).
Storage and Handling: Section 7

DIAZOMETHANE

Synonym: Azimethylene.
Description: Yellow gas at ordinary temperature.
Formula: $CH_2=N^+=N^-$
Constants:
Mol. Wt. 42.04
M. P. −145°C
B. P. −23°C
Density 1.45
Toxic Hazard Rating:
Acute Local: Irritant 3; Inhalation 3
Acute Systemic: U
Chronic Local: Irritant 2; Inhalation 2
Chronic Systemic: U
Explosion Hazard: Severe, when shocked, exposed to heat or by chemical reaction. Undiluted liquid or gas may explode on contact with alkali metals, rough surfaces, heat (100°C) and shock (Section 7).
Disaster Control: Highly dangerous; shock and heat will explode it; when heated to decomposition or on contact with acid or acid fumes; it emits highly toxic fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

1-DIAZO-2-NAPHTHOL-4-SULFONIC ACID

Description: Yellow needles in paste or dry form.
Formula: $C_{10}H_5N_2OSO_3H$
Constants:
Mol. Wt. 250.23
B. P. Decomp. by heat above 100°C
Vap. D. 8.6
Toxicity: Unknown
Explosion Hazard: Moderate, when exposed to heat (Section 7).
Explosive Range: Above 100°C.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur and explodes.
Storage and Handling: Section 7

DIAZONITROPHENOL

Description: Crystals.
Formula: $HOC_6H_4(NO_2)N(\vdots N)$
Constants:
Mol. Wt. 167.1
M. P. Explodes @180°C
Vap. D. 5.8
Toxicity: Unknown
Fire Hazard: See Nitrates.
Explosion Hazard: Severe, when shocked, exposed to heat or by chemical reaction (Section 7).
Disaster Control: See Nitrates.
Storage and Handling: Section 7

5-DIAZOSALICYLIC ACID

Description: Yellow crystals or powder.
Formula: $C_7H_4N_2O_3$
Constants: Mol. Wt. 164.12
M. P. Explodes @155°C
Toxicity: Unknown
Explosion Hazard: Moderate, when exposed to heat (Section 7).
Disaster Control: Dangerous, it emits toxic fumes, and explodes when heated.
Storage and Handling: Section 7

DIBASIC SODIUM o-ARSENATE

Description: White powder.
Formula: $Na_2HAsO_4 \cdot 7H_2O$
Constant: Mol. Wt. 312.0
Density 1.87
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

DIBASIC SODIUM o-ARSENITE

Description: White powder.
Formula: Na_2HAsO_3

Constant:
Mol. Wt. 169.9
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

DIBENAMINE. See Dibenzyl Chloroethylamine Hydrochloride.

2,2'-DIBENZOTHIAZYL DISULFIDE

Synonym: 2,2'-Dithio bis-benzothiazole.
Description: Light-yellow crystals.
Formula: $C_{14}H_8N_2S_4$
Constants:
Mol. Wt. 332.5
M. P. 180°C
B. P. Decomposes
Density 1.50 @20°/4°C
Toxicity: Unknown
Disaster Control: Dangerous; when heated or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

DI-(2-BENZOTHIAZYL-THIOMETHYL)-UREA

Synonym: 1,3-Bis(2-benzothiazolyl mercapto methyl) urea.
Description: Cream-colored powder.
Formula: $(C_6H_4NSCSCH_2NH)_2CO$
Constants:
Mol. Wt. 418.6
M. P. 220°C
Density 1.29 @20°C
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

DIBENZOYL PEROXIDE. See Benzoyl Peroxide.

DIBENZYL ETHER

Description: Liquid.
Formula: $(C_6H_5CH_2)O(C_6H_5CH_2)$
Constants:
Mol. Wt. 198.25
M. P. 5°C
B. P. 298°C
Flash P. 275°F (C.C.)
Density 1.036
Vap. D. 6.84
Toxicity: Details unknown. See also Ethers.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, by spontaneous chemical reaction. See also Ethers.
Storage and Handling: Section 7

DIBENZYL ETHER OF HYDROQUINONE

Synonym: Dibenzoxyhydroquinone.
Description: Powder.
Formula: $C_6H_4(OC_6H_5CH_2)_2$
Constants:
Mol. Wt. 290.3
Vap. D. 10
Toxicity: Details unknown. See also Hydroquinones and Ethers.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

DIBENZYL SEBACATE

Description: Plastic material or light-straw colored liquid.
Formula: $[(CH_2)_4CO_2C_6H_5CH_2]_2$
Constants:
Mol. Wt. 382.5
B. P. 265°C @4 mm
Flash P. 457°F
Density 1.055 @30°/20°C
Toxicity: Details unknown. See also Esters, Benzyl Alcohol and Sebacic Acid.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIBORANE

Synonyms: Boroethane; boron hydride.
Description: Colorless gas, sickly sweet odor.
Formula: B_2H_6
Constants:
Mol. Wt. 27.7
M. P. −165.5°C
B. P. −92.5°C
Density 0.447 (liquid @−112°C);

0.577 (solid @ −183°C)
Vap. Press. 224 mm @ −112°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Inhalation 3
Acute Systemic: Inhalation 3
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (tentative); 0.1 part per million in air.
Fire Hazard: Dangerous, when exposed to flame. See also Boron Hydrides.
Explosion Hazard: Slight, by chemical reaction.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of boron oxides; it will react with water or steam to produce hydrogen; and it can react explosively with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DIBROMOACETYLENE

Synonym: Dibromethyne.
Description: Liquid.
Formula: BrC⋮CBr
Constants:
Mol. Wt. 183.9
M. P. Explodes
B. P. 76°C (approx.)
Density 2 (approx.)
Vap. D. 6.35
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Inhalation 3
Chronic Local: U
Chronic Systemic: U
Explosion Hazard: Severe, when exposed to heat or by spontaneous chemical reaction. Explodes easily with a trace of oxygen (Section 7).
Disaster Control: Highly dangerous; when heated, it emits toxic fumes of bromides; can react explosively with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

p-DIBROMOBENZENE

Description: Crystals, odor of xylene.
Formula: BrC_6H_4Br
Constants:
Mol. Wt. 235.9
M. P. 87°C
B. P. 219°C
Density 2.261
Vap. Press. 1 mm @ 61.0°C
Vap. D. 8.1
Toxicity: Details unknown. A fumigant.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes of bromides.
Storage and Handling: Section 7

DIBROMOCHLOROMETHANE

Description: Colorless to pale yellow, heavy liquid.
Formula: $CHClBr_2$
Constants:
Mol. Wt. 208.3
B. P. 118 - 122°C
Freezing P. < −20°C
Density 2.440 @ 25°/25°C
Toxicity: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

DIBROMODIETHYL SULFIDE

Description: White crystals.
Formula: $(CH_2CH_2Br)_2S$
Constants:
Mol. Wt. 232.00
M. P. 31 - 34°C
B. P. 240°C Decomposes
Density 2.05 @ 15°C
Vap. D. 8.0
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when

heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur and bromides; will react with water or steam to produce toxic and corrosive fumes; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIBROMODIFLUOROMETHANE

Synonym: Difluorodibromomethane.
Description: Colorless, heavy liquid.
Formula: CF_2Br_2
Constants: Mol. Wt. 209.8
B. P. 23.2°C
Freezing P. −141°C
Density 2.288 @15°/4°C
MAC: ACGIH (tentative); 100 parts per million of air.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

1,2-DIBROMOETHYL BENZENE

Synonym: Styrene dibromide.
Description: Colorless liquid.
Formula: $C_6H_5(Br_2C_2H_3)$
Constants:
Mol. Wt. 264.2
B. P. 254.0°C
Freezing P. −43°C
Flash P. None
Density 1.744 @25°/25°C
Vap. Press. 1 mm @86.0°C
Vap. D. 9.1
Toxicity: Details unknown. See also Bromides.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes of bromides.
Storage and Handling: Section 7

DIBROMOFORMOXIME

Description: Crystals.
Formula: CBr_2NOH
Constants:
Mol. Wt. 202.87
M. P. 70 - 71°C
Vap. D. 7.0
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated, it emits highly toxic fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIBROMOGERMANE

Description: Colorless liquid.
Formula: GeH_2Br_2
Constants:
Mol. Wt. 234.45
M. P. −15.0°C
B. P. 89.0°C
Density 2.80 @0°C
Vap. D. 8.1
Toxicity: Details unknown. See also Germanium Compounds and Bromides.
Disaster Control: Moderately dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits toxic fumes of bromides; it will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

DIBROMOKETONE

Formula: $(Br)_2C{=}O$
Constants:
Mol. Wt. 188
Vap. D. 6.5
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated it emits highly toxic fumes; it will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIBROMOMETHYL ETHER

Description: Colorless liquid.

Formula: $(CH_2Br)_2O$
Constants:
  Mol. Wt. 203.90
  M. P. -34°C
  B. P. 154 - 155°C
  Density 2.2
  Vap. D. 7.0
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Details unknown. See also Ethers.
Explosion Hazard: Details unknown. See Also Ethers.
Disaster Control: Dangerous; when heated it emits highly toxic fumes; it can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIBROMO-NITROETHYLBENZENE
Formula:
  $C_6H_3(Br_2)(C_2H_4NO_2)$
Constants:
  Mol. Wt. 309.2
  Vap. D. 10.7
Toxicity: Details unknown. An insecticide.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

DIBUCAINE HYDROCHLORIDE
Synonym: 2-Butoxy-N-(2-diethylaminoethyl) cinchoninamide hydrochloride.
Description: Crystals.
Formula: $C_{20}H_{29}N_3O_2 \cdot HCl$
Constants:
  Mol. Wt. 379.9
  M. P. Decomposes @90 - 98°C
  Vap. D. 13.1
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

DIBUTOXY ETHYL PHTHALATE
Description: Light-colored liquid.
Formula: $C_6H_4(COOC_2H_4OC_4H_9)_2$
Constants:
  Mol. Wt. 366
  M. P. -50°C (becomes viscous)
  B. P. 210 - 233°C @4mm
  Flash P. 407°F
  Density 1.063 @20°/20°C
  Vap. Press. 0.05 mm @150°C
Toxicity: See Esters.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIBUTOXYMETHANE
Description: Liquid.
Formula: $CH_2(OC_4H_9)_2$
Constants:
  Mol. Wt. 160.25
  M. P. 60°C
  B. P. 165 - 188°C
  Flash P. 140°F (C.C.)
  Density 0.838
  Vap. D. 5.5
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIBUTOXY TETRAGLYCOL
Description: Practically colorless liquid with characteristic odor.
Formula: $(C_2H_4OC_2H_4OC_4H_9)_2O$
Constants:
  Mol. Wt. 306.44
  M. P. -20°C
  B. P. 237°C @50 mm
  Flash P. 305°F (O.C.)
  Density 0.9436 @20°/20°C
  Vap. D. 10.6
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIBUTYL ACETAMIDE
Description: Liquid.
Formula: $(C_4H_9)_2CHCONH_2$

Constants:
Mol. Wt. 171.3
B. P. 242°C
Flash P. 225°F
Density 0.89
Vap. D. 5.9
Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIBUTYLAMINE

Description: Liquid.
Formula: $(C_4H_9)_2NH$
Constants: Mol. Wt. 129.2
M. P. -51.1°C
B. P. 159°C
Flash P. 135°F (O. C.)
Density 0.76
Vap. D. 4.46
Vap. Press. 2 mm @20°C
Toxicity: See Amines.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DI-sec-BUTYLAMINE

Description: Liquid.
Formula: $(C_4H_9)_2NH$
Constants:
Mol. Wt. 129.2
B. P. 134°C
Flash P. 75°F
Density 0.75
Vap. D. 4.5
Toxicity: See Amines.
Fire Hazard: Dangerous; when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

DIBUTYLAMINOETHANOL

Description: Liquid.
Formula: $(C_4H_9)_2NCH_2CH_2OH$
Constants:
Mol. Wt. 173.3
B. P. 222°C
Flash P. 200°F
Density 0.85
Vap. D. 6.0
Toxicity: Details unknown. See also Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride.
Storage and Handling: Section 7

DIBUTYLANILINE

Description: Liquid.
Formula: $C_6H_5N(C_4H_9)_2$
Constants:
Mol. Wt. 205.3
B. P. 266°C
Flash P. 446°F
Density 0.94
Vap. D. 7.1
Toxicity: Details unknown. See also Aniline.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of nitrogen compounds; can react vigorosuly with oxidizing materials.
Storage and Handling: Section 7

2,5-DI-tert-BUTYL BENZOQUINONE

Description: Crystals.
Formula: $(O)_2 \cdot C_6H_2 \cdot (C(CH_3)_3)_2$
Constants: Mol. Wt. 220.3
M. P. 150°C
Vap. D. 7.6
Toxicity: Details unknown. See also Quinone.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

DIBUTYL BERYLLIUM

Description: Colorless liquid.
Formula: $Be(C_4H_9)_2$
Constants:
Mol. Wt. 123.25
B. P. 170°C @25 mm
Vap. D. 4.2
Toxicity: See Beryllium Compounds.
Fire Hazard: Moderate, when in contact with heat or flame (Section 6).
Disaster Control: Dangerous; when

heated to decomposition, it emits highly toxic fumes of beryllium and it can react vigorously with oxidizing materials.
Storage and Handling: Section 7

DI-tert-BUTYL BERYLLIUM
Description: A clear, colorless, mobile liquid.
Formula: $Be(C_4H_9)_2$
Constants:
Mol. Wt. 123.25
M. P. -16°C
Density 0.65
Vap. Press. 35 mm @25°C
Vap. D. 4.2
Toxicity: See Beryllium Compounds.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; it can react vigorously with oxidizing materials.
Storage and Handling: Section 7

DIBUTYL BUTYL PHOSPHONATE
Description: Colorless liquid, mild odor.
Formula: $C_4H_9P(O)(OC_4H_9)_2$
Constants:
Mol. Wt. 250.3
B. P. 128°C @2.5 mm
Flash P. 311°F (C.O.C.)
Density 0.948 @20°/4°C
Vap. D. 8.62
Toxicity: Unknown.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus; it can react vigorously with oxidizing materials.
Storage and Handling: Section 7

DIBUTYL "CARBITOL". See Diethylene Glycol Dibutyl Ether.

DIBUTYL "CELLOSOLVE". See Ethylene Glycol Dibutyl Ether.

DI(BUTYL "CELLOSOLVE") ETHYLENE BIS-GLYCOLATE
Description: Liquid.
Formula: $(CH_2OCH_2CO_2CH_2CH_2OC_4H_9)_2$
Constants:
Mol. Wt. 378.5
B. P. 199 - 207°C @1.3 mm
Flash P. 410°F (O.C.)
Density 1.0667 @25°/25°C
Vap. D. 13.1
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIBUTYL "CELLOSOLVE" PHTHALATE
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when heated, it emits acrid fumes, and can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

DIBUTYL "CELLOSOLVE" SUCCINATE
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight; when heated, it emits acrid fumes and can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

DIBUTYL CHLOROPHOSPHATE
Description: Water-white liquid.
Formula: $(C_4H_9O)_2POCl$
Constants:
Mol. Wt. 228.5
B. P. 103 - 106°C @1.5 mm
Density 1.0742 @20°/20°C
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of phosphorus.
Storage and Handling: Section 7

DI-tert-BUTYL-m-CRESOL
Synonym: DBMC
Description: Yellow, crystalline solid.
Formula: $C_{15}H_{24}O$
Constants:
Mol. Wt. 220.3

M. P. 62.1°C
B. P. 282°C
Flash P. 262°F (O.C.)
Density 0.912 @80°/4°C
Toxicity: Details unknown. See also Cresol.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; it can react with oxidizing materials.
Storage and Handling: Section 7

DI-tert-BUTYL-p-CRESOL
Synonyms: DBPC; 4-methyl-2, 6-di-tert-butyl phenol.
Description: White, crystalline solid.
Formula: $C_6H_2(C_4H_9)_2(CH_3)OH$
Constants:
Mol. Wt. 220.3
B. P. 265°C
Freezing P. 68°C
Flash P. 260°F (T.O.C.)
Density 1.048 @20°/4°C
Vap. D. 7.6
Toxicity: Details unknown. See also Cresol.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; it can react with oxidizing materials.
Storage and Handling: Section 7

o, o'-**DI-tert-BUTYL-p-CRESOL.** See Di-tert-Butyl-p-Cresol.

N, N-**DIBUTYL ETHANOLAMINE.** See Dibutylaminoethanol.

n-**DIBUTYL ETHER.** See n-Butyl Ether.

DIBUTYL ETHYLENE BISGLYCOLATE
Description: Liquid.
Formula: $(CH_2OCH_2CO_2C_4H_9)_2$
Constants:
Mol. Wt. 290.4
B. P. 145 - 150°C @0.6 mm
Flash P. 248°F (O.C.)
Density 1.0391 @25°/25°C
Vap. D. 10.0
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIBUTYL FUMARATE
Description: Colorless, clear, mobile, liquid. Typical odor.
Formula: $C_4H_9OCOCHCHCOOC_4H_9$
Constants:
Mol. Wt. 228.28
B. P. 285.1°C
Freezing P. -19°C
Flash P. 300°F (O.C.)
Density 0.986 @20°/20°C
Vap. D. 7.88
Toxicity: See Esters, Fumaric Acid and Butyl Alcohol.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIBUTYL HEXAHYDROPHTHALATE
Synonym: Dibutyl-1, 2-cyclohexane dicarboxylic acid.
Description: Liquid
Formula: $C_6H_{10}(CO_2C_4H_9)_2$
Constants:
Mol. Wt. 284.4
B. P. 185°C
Flash P. 305°F
Density 1.0
Vap. D. 9.8
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIBUTYL ISOPHTHALATE
Synonym: Dibutyl m-phthalate.

Description: Oily liquid.
Formula: $C_6H_4(COOC_4H_9)_2$
Constants:
Mol. Wt. 278.3
Flash P. 322°F
Vap. D. 9.58
Toxicity: See Phthalic Acid and Butyl Alcohol.
Fire Hazard: Slight, when exposed to heat and flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIBUTYL ISOPROPANOLAMINE

Synonym: 2-Propanol-1-N, N-dibutylamine.
Description: Liquid.
Formula: $CH_3CHOHCH_2N(C_4H_9)_2$
Constants:
Mol. Wt. 187.3
M. P. −80°C
B. P. 229°C
Flash P. 205°F (O. C.)
Density 0.8419 @20°/20°C
Vap. Press. < 0.1
Vap. D. 6.5
Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIBUTYL LAURAMIDE

Description: Liquid.
Formula: $(C_4H_9)_2CH(CH_2)_{10}CONH_2$
Constants:
Mol. Wt. 311.5
B. P. 200°C
Flash P. 375°F
Density 0.86
Vap. D. 10.7
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIBUTYL MALEATE

Description: Liquid.
Formula: $C_4H_9OOCHCCHCOOC_4H_9$
Constants:
Mol. Wt. 228.3
M. P. −85°C (sets to a glass)
B. P. 281°C
Flash P. 285°F (O. C.)
Density 0.9964 @20°/20°C
Vap. D. 7.9
Toxicity: Details unknown. See also Esters and Butyl Alcohol.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIBUTYL MERCURY

Description: Liquid.
Formula: $Hg(C_4H_9)_2$
Constants:
Mol. Wt. 314.8
B. P. 105°C @10 mm
Density 1.7779
Vap. D. 10.8
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes; it emits highly toxic fumes of mercury; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

DIBUTYL METHIONATE

Description: Liquid.
Formula: $CH_2(SO_3C_4H_9)_2$
Constants:
Mol. Wt. 288.3
Vap. D. 10.0
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; it will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

2, 6-DI-t-BUTYL-4-METHYL PHENOL

Description: Granular crystals.
Formula:
$(CH_3)_3C\text{-}C_6H_2(OH)(CH_3)\text{-}C(CH_3)_3$

Constants:
Mol. Wt. 220.3
M. P. 70°C
B. P. 265°C
Flash P. 260°F (T.O.C.)
Density 0.899 @80°/4°C
Vap. D. 7.61
Toxicity: Details unknown. See also Phenol.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phenol; can react with oxidizing materials.
Storage and Handling: Section 7

DIBUTYLOLEAMIDE
Description: Liquid.
Formula: $(C_4H_9)_2C_8H_{17}CHCH(CH_2)_7CON$
Constants:
Mol. Wt. 393.7
B. P. 220°C
Density 0.85
Vap. D. 13.6
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

DIBUTYL OXALATE
Description: Water-white, high-boiling liquid, mild odor.
Formula: $(COOC_4H_9)_2$
Constants:
Mol. Wt. 202.3
M. P. −30°C
B. P. 246°C
Flash P. 220°F (C.C.)
Density 0.989 - 0.993 @20°/20°C
Vap. D. 7.0
Toxicity: See Oxalic Acid.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DI-tert-BUTYL PEROXIDE
Description: Clear, water-white liquid.
Formula: $(C_4H_9O)_2$
Constants:
Mol. Wt. 146.2
M. P. −40°C
B. P. 80°C @284 mm
Flash P. 65°F (C.C.)
Density 0.79
Vap. Press. 19.51 mm @20°C
Vap. D. 5.03
Toxicity: Details unknown. See also Peroxides, Organic.
Fire Hazard: Dangerous, when exposed to heat or flame or by chemical reaction with reducing agents.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or by spontaneous chemical reaction (Section 6). See also Peroxides, Organic.
Disaster Control: Dangerous; when heated, it may explode; can react with oxidizing or reducing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

DI-sec-BUTYL PHENOL
Description: Amber liquid.
Formula: $(CH_3CHC_2H_5)_2C_6H_3OH$
Constants:
Mol. Wt. 206.3
B. P. 152 - 165°C @25mm
Freezing P. −50°C
Flash P. 280°F
Density 0.936 @25°/4°C
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2,4-DI-tert-BUTYL PHENOL
Description: Tan crystals.
Formula: $HOC_6H_3(C_4H_9)_2$
Constants:
Mol. Wt. 206.3
M. P. 51°C
B. P. 260.8°C
Flash P. 265°F
Density 0.907 @60°/4°C
Vap. Press. 1 mm @84.5°C
Toxicity: Details unknown.

See also Phenol.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

N, N'-DI-sec-BUTYL p-PHENYLENE DIAMINE
Description: Liquid.
Formula: $C_6H_4(CH_3CHNHCH_2CH_3)_2$
Constants:
Mol. Wt. 220.4
M. P. 17.8°C
Flash P. 285°F (O.C.)
Density 0.94 - 0.95 @24°/24°C
Toxicity: A mild allergen. Individual susceptibility to these materials may vary. Should be handled with care. See also p-Phenylene Diamine.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIBUTYL PHOSPHITE
Description: Liquid.
Formula: $(C_4H_9O)_2P(O)H$
Constants:
Mol. Wt. 194.2
B. P. 115°C @10 mm
Flash P. 248°F
Density 0.971 @35°/4°C
Vap. Press. < 1 mm @20°C
Vap. D. 6.7
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame or by chemical reaction. Many phosphites decompose to evolve phosphine when heated (Section 6).
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride.
Explosion Hazard: See Phosphine.
Disaster Control: Dangerous, when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of phosphorus; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

DIBUTYL-m-PHTHALATE
Synonym: Dibutyl isophthalate.
Description: Liquid.
Formula: $(C_6H_4)(CO_2C_4H_9)_2$
Constants:
Mol. Wt. 278.3
Flash P. 322°F (C.C.)
Vap. D. 9.58
Toxicity: See Esters, Butyl Alcohol and Phthalic Acid.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIBUTYL o-PHTHALATE
Synonym: Dibutyl-1,2-benzene dicarboxylate.
Description: Oily liquid, mild odor.
Formula: $C_6H_4(COOC_4H_9)_2$
Constants:
Mol. Wt. 278.3
B. P. 340°C
Freezing P. -35°C
Flash P. 315°F (C.C.)
Density 1.047 - 1.049 @20°/20°C
Autoign. Temp. 757°F
Vap. D. 9.58
Toxicity: See Esters, Phthalic Acid and Butyl Alcohol.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIBUTYL SEBACATE
Decription: Clear liquid.
Formula: $[(CH_2)_4COOC_4H_9]_2$
Constants:
Mol. Wt. 314.45
B. P. 180°C @3 mm
Freezing P. -11°C
Flash P. 353°F (C.O.C.)
Density 0.936 @20°/20°C
Vap. D. 10.8
Toxicity: See Esters and Butyl Alcohol.
Fire Hazard: Slight, when exposed to heat or flame; can react with

oxidizing materials.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIBUTYL STEARAMIDE
Description: Liquid.
Formula: $CH_3(CH_2)_{16}CON(C_4H_9)_2$
Constants:
Mol. Wt. 395.7
B. P. 175°C
Flash P. 420°F
Density 0.86
Vap. D. 13.7
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIBUTYL TARTRATE
Synonym: Dibutyl-d-2,3-dihydroxybutane dioate.
Description: Light tan liquid, mild odor.
Formula: $(COOC_4H_9)_2(CHOH)_2$
Constants:
Mol. Wt. 262.30
M. P. 21°C
B. P. 204°C @26 mm
Flash P. 195°F (C.C.)
Density 1.087 - 1.093 @20°/20°C
Autoign. Temp. 544°F
Vap. D. 9.03
Toxicity: See Esters, Butyl Alcohol and Tartaric Acid.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

1,3-DIBUTYLTHIOUREA
Description: White to light tan powder.
Formula: $C_4H_9NHCSNHC_4H_9$
Constants:
Mol. Wt. 188.4
M. P. 60°C
Vap. D. 6.5
Toxicity: Details unknown. See also Thiourea.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

DIBUTYL TIN DIACETATE
Synonym: Dibutyldiacetoxystannane.
Description: Clear, coloress liquid with a slight acetic acid odor.
Formula: $(C_4H_9)_2Sn(CH_3CO_2)_2$
Constants:
Mol. Wt. 351.0
B. P. Decomposes
Freezing P. 5 - 10°C
Flash P. 290°F (O.C.)
Density 1.31 @25°C
Vap. D. 12.1
Toxicity: Probably slight. See Tin Compounds and Butyl Alcohol.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIBUTYL TIN DICHLORIDE
Synonym: Dibutyldichlorostannane.
Description: White, crystalline solid.
Formula: $(C_4H_9)_2SnCl_2$
Constants:
Mol. Wt. 303.8
M. P. 43°C
B. P. 135°C 10 mm
Flash P. 335°F (O.C.)
Density 1.36 @50°C
Vap. Press. 2 mm @100°C
Vap. D. 10.5
Toxicity: See Tin Compounds, Butyl Alcohol, Hydrochloric Acid.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; it emits highly toxic fumes of hydrochloric acid; will react with water or steam to produce heat and toxic fumes; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

DIBUTYL TIN DILAURATE
Description: Pale yellow liquid to colorless solid (when pure).
Formula: $(C_4H_9)_2Sn(O_2C[CH_2]_{10}CH_3)_2$

Constants:
Mol. Wt. 631.5
M. P. 27°C
B. P. Nondistillable @10 mm
Flash P. 455°F (O. C.)
Density 1.066 @20°/20°C
Vap. D. 21.8
Toxicity: See Tin Compounds and Butyl Alcohol.
Caution: The vapors evolved when this material is heated should be avoided. A skin irritant.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIBUTYL TIN MALEATE

Synonym: Dibutylmalyldioxystannane.
Description: A white, amorphous powder or glass-like resin.
Formula: $(C_4H_9)_2Sn(CHCO_2)_2$
Constants:
Mol. Wt. 347.0
M. P. 110°C
Flash P. 400°F (O. C.)
Bulk Density 0.36
Vap. D. 12.0
Toxicity: See Tin Compounds.
Caution: Avoid vapors emitted when this material is hot.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

DIBUTYL TIN OXIDE

Synonym: Dibutyloxostannane.
Description: White, amorphous powder.
Formula: $(C_4H_9)_2SnO$
Constants:
Mol. Wt. 248.9
M. P. Decomp. without melting.
Bulk Density 0.5
Vap. D. 8.6
Toxicity: See Tin Compounds and Butyl Alcohol.
Fire Hazard: Ignites when exposed to flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

DIBUTYL UREA

Description: Liquid.
Formula: $C_4H_9NHCONHC_4H_9$
Constants:
Mol. Wt. 172.3
M. P. 25°C
B. P. 119°C
Flash P. 279°F
Vap. D. 5.95
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DICAPRYL ADIPATE

Description: Liquid.
Formula: $(CH_2CH_2CO_2C_8H_{17})_2$
Constants:
Mol. Wt. 370.6
B. P. 211 - 217°C @4 mm
Flash P. 352°F
Density 0.916 @20°/20°C
Vap. D. 12.8
Toxicity: See Esters.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DICAPRYL PHTHALATE

Description: Clear liquid.
Formula: $C_6H_4(CO_2C_8H_{17})_2$
Constants:
Mol. Wt. 390.6
B. P. 222 - 230 @4 mm
Freezing P. -60°C
Flash P. 394°F (C.O.C.)
Density 0.978 @20°/20°C
Toxicity: See Esters.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DICAPRYL SEBACATE

Description: Liquid.

Formula: $[(CH_2)_4CO_2C_8H_{17}]_2$
Constants:
  Mol. Wt. 426.7
  B. P. 230 - 240°C @4 mm
  Flash P. 445°F
  Density 0.907 @20°/20°C
  Vap. D. 14.7
Toxicity: See Esters.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Slightly dangerous; can react with oxidizing materials.
Storage and Handling: Section 7

DICARBON HEXABROMIDE

Synonym: Hexabromoethane.
Description: Rhombic crystals.
Formula: C_2Br_6
Constants:
  Mol. Wt. 503.52
  M. P. 149°C Decomposes
  B. P. 210°C
  Density 3.823
  Vap. D. 18.2
Toxicity: Details unknown. See also Bromides.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes of bromides and will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

DICARBON HEXACHLORIDE

Synonym: Hexachloroethane.
Description: Rhombic, triclinic or cubic, colorless crystals.
Formula: C_2Cl_6
Constants:
  Mol. Wt. 236.76
  M. P. Sublimes @187°C
  B. P. 184°C
  Density 2.091
  Vap. D. 8.2
Toxicity: Details unknown. See also Chlorinated Hydrocarbons.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and it will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

DICARBONTETRABROMIDE

Synonyms: Carbon dibromide; tetrabromethylene.
Description: Solid.
Formula: C_2Br_4
Constants:
  Mol. Wt. 343.68
  M. P. 57.5°C
  B. P. 227°C
  Vap. D. 11.9
Toxicity: Details unknown. See also Bromides.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes of bromides.
Storage and Handling: Section 7

DICARBONTETRACHLORIDE. See Tetrachloroethylene.

DICHLOROACETALDEHYDE

Synonym: 2,2-Dichlorethanal.
Description: Colorless liquid, polymerizes slowly to white solid.
Formula: $CHCl_2CHO$
Constants:
  Mol. Wt. 112.95
  B. P. 88°C
  Freezing P. −50°C
  Flash P. 140°F (C.C.)
  Density 1.436 @25°/4°C
  Vap. Press. 50 mm @20°C
  Vap. D. 3.9
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DICHLOROACETIC ACID

Description: Colorless, corrosive pungent odor.

Formula: $CHCl_2COOH$
Constants:
Mol. Wt. 129.0
M. P. a: 10°C; b: -4°C
B. P. 194°C
Density 1.5634 @20°/4°C
Vap. Press. 1 mm @44.0°C
Vap. D. 4.45
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Caution: The LD50 for dosage by mouth is of the same order of magnitude as acetic acid or trichloroacetic acid. It is corrosive and irritating to the skin and mucous membranes.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; it will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

1,1-DICHLOROACETONE

Synonym: 1,1-Dichloro-2-propanone.
Description: Oily liquid.
Formula: $CH_3COCHCl_2$
Constants:
Mol. Wt. 127.0
B. P. 120°C
Density 1.305 @18°/15°C
Vap. D. 4.38
Toxicity: Details unknown. See also Ketones.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

1,3-DICHLOROACETONE

Synonym: 1,3-Dichloro-2-propanone
Description: Crystals.
Formula: $CH_2ClCOClCH_2$
Constants:
Mol. Wt. 127.0
M. P. 45°C
B. P. 173°C
Density 1.3826 @46°/4°C
Vap. D. 4.38
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DICHLOROACETONITRILE

Formula: $CHCl_2CN$
Constants:
Mol. Wt. 110.0
Vap. D. 3.8
Toxicity: See Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

alpha, alpha-DICHLOROACETOPHENONE

Description: Crystals.
Formula: $C_6H_5COCHCl_2$
Constants:
Mol. Wt. 189.05
M. P. 21°C
B. P. 247°C Decomposes
Density 1.34 @15°C
Vap. D. 6.5
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DICHLOROACETYLENE

Synonyn: Dichloracetylene.
Formula: $ClC\vdots CCl$
Constant:
Mol. Wt. 94.94
Toxicity: Details unknown. See also Chlorinated Hydrocarbons.

Explosion Hazard: Severe, when shocked or exposed to heat (Section 7).
Disaster Control: Highly dangerous; shock and heat will explode it; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

2, 5-DICHLOROANILINE
Description: Needle-like crystals.
Formula: $Cl_2C_6H_3NH_2$
Constants:
 Mol. Wt. 162.0
 B. P. 251°C
 M. P. 50°C
 Vap. D. 5.6
Toxicity: Details unknown. See also Aniline.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

m-DICHLOROBENZENE
Synonym: 1, 3-Dichlorobenzene.
Description: Colorless liquid.
Formula: $C_6H_4Cl_2$
Constants:
 Mol. Wt. 147.0
 M. P. -24.8°C
 B. P. 173°C
 Density 1.288 @20°/4°C
 Vap. Press. 1 mm @12.1°C
 Vap. D. 5.08
Toxicity: An insecticide and fumigant. See also o-Dichlorobenzene and Chlorobenzenes.
Fire Hazard: Moderate.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

o-DICHLOROBENZENE
Description: Clear liquid.
Formula: $C_6H_4Cl_2$
Constants: Mol. Wt. 147.0
 M. P. -17.5°C
 B. P. 180 - 183°C
 Freezing P. -22°C
 Flash P. 155°F
 Density 1.307 @20°/20°C
 Vap. D. 5.05
Toxic Hazard Rating:
 Acute Local: Irritant 1; Allergen 1; Ingestion 1
 Acute Systemic: Ingestion 2; Inhalation 2
 Chronic Local: Irritant 1; Allergen 1
 Chronic Systemic: Ingestion 2; Inhalation 2
MAC: ACGIH (accepted); 50 parts per million in air; 300 milligrams per cubic meter of air.
Toxicology: See also Chlorobenzenes.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

p-DICHLOROBENZENE
Synonym: 1, 4-Dichlorobenzene.
Description: White crystals, penetrating odor.
Formula: $C_6H_4Cl_2$
Constants:
 Mol. Wt. 147.0
 M. P. 53°C
 B. P. 173.4°C
 Flash P. 150°F (C. C.)
 Density 1.4581 @20.5°/4°C
 Vap. Press. 10 mm @54.8°C
 Vap. D. 5.08
Toxic Hazard Rating:
 Acute Local: Irritant 1; Allergen 1; Ingestion 2; Inhalation 1
 Acute Systemic: Ingestion 2
 Chronic Local: Irritant 2; Allergen 1
 Chronic Systemic: Ingestion 1; Inhalation 1
Fire Hazard: Moderate, when exposed to heat or flame.
Spontaneous Heating: No

To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DICHLOROBENZIDINE

Description: Crystalline solid.
Formula: $C_6H_3ClNH_2C_6H_3ClNH_2$
Constants:
Mol. Wt. 253.14
M. P. 133°C
Vap. D. 8.73
Toxicity: Details unknown. See also Benzidine.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

3, 4-DICHLOROBENZYL ALCOHOL

Description: Crystals.
Formula: $Cl_2C_6H_3CH_2OH$
Constants:
Mol. Wt. 177.1
Vap. D. 6.1
Toxicity: Details unknown; an insecticide. See also Alcohols.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

2, 4-DICHLOROBENZYL CHLORIDE

Description: Liquid.
Formula: $Cl_2C_6H_3CH_2Cl$
Constants:
Mol. Wt. 195.5
Vap. D. 6.76
Toxicity: Details unknown; an insecticide.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

3, 4-DICHLOROBENZYL CHLORIDE

Description: Liquid.
Formula: $Cl_2C_6H_3CH_2Cl$
Constants: Mol. Wt. 195.5
B. P. 255°C
Vap. D. 6.76
Toxicity: Details unknown; an insecticide.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

1, 1-DICHLORO-2, 2-BIS(p-CHLOROPHENYL) ETHANE

Synonyms: Tetrachlorodiphenylethane; TDE
Description: Crystals.
Formula: $C_{14}H_{10}Cl_4$
Constants: Mol. Wt. 320.05
M. P. 110°C
Vap. D. 11.0
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1
Acute Systemic: Ingestion 2
Chronic Local: Allergen 1
Chronic Systemic: Ingestion 2
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Personal Hygiene: Section 3
Storage and Handling: Section 7

1, 4-DICHLOROBUTANE

Synonym: Sym-dichlorobutane.
Description: Colorless, mobile liquid with mild, pleasant odor.
Formula: $CH_2ClCH_2CH_2CH_2Cl$
Constants:
Mol. Wt. 127.02
B. P. 155°C
Flash P. 126°F (C.C.)
Density 1.141
Vap. D. 4.4
Vap. Press. 4 mm @20°C
Toxicity: A moderately toxic liquid; about $^1/_7$ as toxic as tetrachloroethane. See also Chlorinated Hydrocarbons.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

2, 3-DICHLOROBUTANE

Description: Liquid.

Formula: $CH_3CHClCHClCH_3$
Constants:
Mol. Wt. 127
M. P. −80.4°C
B. P. 116.0°C
Flash P. 70°F
Vap. Press. 40 mm @35.0°C
Vap. D. 4.4
Toxicity: Details unknown. See also Chlorinated Hydrocarbons.
Fire Hazard: Dangerous; when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

DICHLOROBUTENE

Synonym: 1,3-Dichloro-2-butene.
Formula: $CH_2ClCHCClCH_3$
Constants:
Mol. Wt. 125.01
B. P. 123°C
Flash P. 80°F (C.C.)
Vap. D. 4.31
Toxicity: Details unknown. See also Chlorinated Hydrocarbons.
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

DICHLORO-(2-CHLOROVINYL) ARSINE

Synonyms: 2-Chlorovinyl dichloroarsine; Lewisite.
Description: Liquid, faint odor of geranium.
Formula: $C_2H_2AsCl_3$
Constants:
Mol. Wt. 207.32
B. P. 190°C Decomposes
Freezing P. −13°C
Density 1.888 @20°/4°C
Vap. Press. 0.4 mm @20°C
Vap. D. 7.15
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Toxicology: A blistering type military poison. Has a delayed action similar to distilled mustard gas. This gas exhibits a systemic poisoning effect. To decontaminate, use bleach sol., DANC sol., M5 ointment or fire. This material is absorbed through skin. As little as 2 ml can cause death.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of arsenic.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DICHLORODIETHYL SILANE

Description: Liquid.
Formula: $C_4H_{10}Cl_2Si$
Constants:
Mol. Wt. 157.05
M. P. −96°C
B. P. 130.4°C
Density 1.05 @25°/25°C
Vap. Press. 10 mm @25.4°C
Vap. D. 5.41
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of hydrochloric acid; it will react with water or steam to produce heat, toxic and corrosive fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DICHLORODIETHYL SULFIDE

Synonyms: Distilled mustard gas; HD

Description: Colorless (if pure), to light yellow, oily liquid.

Formula: $S(CH_2CH_2Cl)_2$

Constants:
- Mol. Wt. 159.1
- B. P. 228°C
- Freezing P. 14.4°C
- Flash P. 221°F
- Density 1.2741 @20°/4°C
- Vap. Press. 0.09 mm @30°C
- Vap. D. 5.4

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
- Chronic Local: U
- Chronic Systemic: U

Toxicology: A "blistering" gas. Highly irritant to eyes, skin and lungs. Pulmonary lesions are often fatal. However, effects upon eyes and skin are likewise serious. There can also be severe gastric distrubances. Only slight evidence for systemic damage. This material penetrates deeply and injures blood vessels which can result in a severe inflammatory reaction and tissue necrosis. Exposure, even to minute traces can lead to intense inflammation after some hours. It produces marked leucopenia with involution of the lymph nodes; secondary infections are common.

Treatment of local lesions is mainly by cleanliness and emollients, similar to that of burns. Oils protect the skin only slightly. Immediately after exposure, the poison may be partly removed by scrubbing the victim with kerosene, but penetration is so rapid that this treatment is not successful if delayed for 15 to 30 minutes.

Fire Hazard: Slight, when exposed to heat or flame; can be ignited by a large explosive charge.

To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur and chlorides; it will react with water or steam to produce toxic and corrosive fumes; it can react vigorously with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

DICHLORODIETHYLSULFONE

Description: Colorless crystals.

Formula: $(CH_2CH_2Cl)_2O_2S$

Constants:
- Mol. Wt. 191.08
- M. P. 52°C
- B. P. 179 - 181°C @14 - 15 mm
- Vap. D. 6.6

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of chlorides and oxides of sulfur.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

1,1-DICHLORO-2,2-DIFLUOROETHYLENE

Description: Liquid.

Formula: Cl_2CCF_2

Constants:
- Mol. Wt. 133
- Vap. D. 4.6

Toxic Hazard Rating:
- Acute Local: U
- Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
- Chronic Local: U
- Chronic Systemic: Ingestion 1; Inhalation 1; Skin Absorption 1

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides and chlorides; it will react with water or steam to produce toxic and corrosive fumes.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DICHLORODIFLUOROGERMANE
Description: Colorless gas.
Formula: $GeCl_2F_2$
Constants:
  Mol. Wt. 181.51
  M. P. −51.8°C
  B. P. −2.8°C
Toxicity: See Fluorides and Germanium Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of fluorides and chlorides.
Storage and Handling: Section 7

DICHLORODIFLUOROMETHANE
Synonym: "Freon-12"
Description: Colorless, almost odorless gas.
Formula: CCl_2F_2
Constants:
  Mol. Wt. 120.92
  M. P. −21.5°F
  B. P. −29°C
  Vap. Press. 5 atm @16.1°C
Toxic Hazard Rating:
  Acute Local: 0
  Acute Systemic: Inhalation 1
  Chronic Local: U
  Chronic Systemic: Inhalation 1
MAC: ACGIH (accepted); 1000 parts per million in air; 5000 milligrams per cubic meter of air.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene and fluorides.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Nonflammable gas; green label.
  Coast Guard Classification: Noninflammable gas; green label.

1,3-DICHLORO-5,5-DIMETHYL HYDANTOIN
Synonyms: Dichlorodimethyl hydantoin.
Description: A source of active chlorine.
Formula: $C_5H_6N_2Cl_2O_2$
Constants:
  Mol. Wt. 197
  M. P. 130°C (approx.)
  Density 1.5 @20°C
  Vap. D. 6.8
Toxicity: Details unknown. Toxicity to warm-blooded animals appears to be low. Avoid excessive contact because of effects of active chlorine to irritate the skin. Some of the hydantoins are central nervous system depressants.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and it will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

DICHLORODIMETHYLSILANE
Description: Liquid.
Formula: $C_2H_6Cl_2Si$
Constants:
  Mol. Wt. 129.02
  M. P. Below −70°C
  B. P. 70.5°C
  Density 1.07 @25°/25°C
  Vap. D. 4.45
Toxic Hazard Rating;
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and it will react with water or steam to produce heat, toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

1,8-DICHLORO-3,6-DINITRO-CARBAZOLE
Description: Crystals.
Formula: $(NO_2ClC_6H_2NH)_2$
Constant:
  Mol. Wt. 341.1
Toxicity: Details unknown. An insecticide. See also Nitro Compounds of Aromatic Hydrocarbons.
Disaster Control: Dangerous; when heated to decomposition, it emits

highly toxic fumes of chlorides and oxides of nitrogen; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

DICHLORODIPHENYL OXIDE

Synonym: Dichlorodiphenylene oxide.
Description: Liquid.
Formula: $Cl_2C_{12}H_6O$
Constants:
Mol. Wt. 237.1
Vap. D. 8.2
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

DICHLORODIPHENYLTRICHLOROETHANE. See DDT.

DICHLOROETHANE. See Ethylene Dichloride.

1,1-DICHLOROETHANE. See Ethylidene Chloride.

1,2-DICHLOROETHYL ACETATE

Description: Water-white liquid.
Formula: $CH_3COOCHClCH_2Cl$
Constants:
Mol. Wt. 157
M. P. Below -32°C
B. P. 58-65°C @13 mm
Flash P. 307°F
Density 1.296 @20°C
Vap. D. 5.42
Toxicity: Details unknown. See also Esters, Alcohols and Acetic Acid.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire : Water, foam, carbon, dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

1,2-DICHLOROETHYL ALCOHOL

Synonym: alpha,beta-Dichloroethyl alcohol.
Description: Liquid.
Formula: $CH_2ClCHClOH$
Constants: Mol. Wt. 115.0
Vap. D. 3.97
Toxicity: Details unknown. See also Alcohols.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

ar-DICHLOROETHYL BENZENE

Description: Colorless liquid.
Formula: $Cl_2C_6H_3CH_2CH_3$
Constants: Mol. Wt. 175.1
M. P. < -70°C
B. P. 220 - 224°C
Flash P. 205°F
Density 1.208 @25°/25°C
Vap. D. 6.05
Toxicity: Details unknown. See also Chlorinated Hydrocarbons, Aromatic.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

1,2-DICHLOROETHYL BENZENE

Description: Clear, colorless liquid.
Formula: $Cl_2C_6H_3CH_2CH_3$
Constants:
Mol. Wt. 175.1
M. P. < -70°C
B. P. 224 - 226°C
Flash P. 401°F
Density 1.21 @25°/25°C
Vap. D. 6.05
Toxicity: Details unknown. See also Chlorinated Hydrocarbons, Aromatic.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

cis-DICHLOROETHYLENE

Synonyms: 1,2-Dichloroethylene; acetylene dichloride.

Description: Colorless liquid, pleasant odor.

Formula: $C_2H_2Cl_2$

Constants: Mol. Wt. 97.0
M. P. −80.5°C
B. P. 59°C
Flash P. 43°F
Density 1.2743 @25°/4°C
Vap. Press. 400 mm @41.0°C
Vap. D. 3.34

Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Chronic Local: U
Chronic Systemic: U

MAC: ACGIH (accepted); 200 parts per million in air; 794 milligrams per cubic meter of air. See also Chlorinated Hydrocarbons.

Fire Hazard: Dangerous, when exposed to heat or flame.

Spontaneous Heating: No

To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Moderate, in the form of vapor when exposed to flame (Section 7).

Explosive Range: 9.7 - 12.8%

Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

trans-DICHLOROETHYLENE

Synonym: Acetylene dichloride.

Description: Colorless liquid, pleasant odor.

Formula: $C_2H_2Cl_2$

Constants:
Mol. Wt. 97.0
M. P. −50.0°C
B. P. 47.8°C
Flash P. 43°F
Density 1.2743 @25°/4°C
Vap. Press. 400 mm @30.8°C
Vap. D. 3.34

Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2; Skin Abosrption U
Chronic Local: U
Chronic Systemic: U

MAC: ACGIH (accepted); 200 parts per million in air; 794 milligrams per cubic meter of air. See also Chlorinated Hydrocarbons, Aliphatic.

Fire Hazard: Dangerous, when exposed to heat or flame.

Spontaneous Heating: No

To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Moderate in the form of vapor when exposed to flame (Section 7).

Explosive Range: 9.7 - 12.8%

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

2,2'-DICHLOROETHYL ETHER

Synonyms: Chlorex; 1-chloro-2-(beta-chloroethoxy) ethane.

Description: Colorless, stable liquid.

Formula: $ClCH_2CH_2OCH_2CH_2Cl$

Constants:
Mol. Wt. 143.0
B. P. 178.5°C
Freezing P. −51.9°C
Flash P. 131°F (C. C.)
Density 1.2220 @20°/20°C
Autoign. Temp. 696°F
Vap. Press. 0.7 mm @20°C
Vap. D. 4.93

Toxic Hazard Rating:
Acute Local: Irritant 3; Inhalation 3
Acute Systemic: Ingestion 3;

Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3
MAC: ACGIH (accepted); 15 parts per million in air; 88 milligrams per cubic meter of air.
Toxicology: The vapor is irritant to the mucous membranes of the eyes and nose. It affects the kidneys and liver in varying degrees, and is a mild narcotic. Guinea pigs cannot be killed immediately by exposure to concentrations which can be attained at ordinary room temperature, but exposure to 1,000 ppm for 30 to 60 minutes may produce death after several days. Autopsy shows congestion of the lungs and upper respiratory tract, pulmonary edema, and congestion of the liver, brain and kidneys. The pulmonary edema apparently develops after a latent period of several hours, similar to the action of "nitrous fumes". In humans, exposure to 500 to 1,000 ppm causes severe irritation of the eyes and nose after brief exposure, and deep inhalation is nauseating and intolerable. A concentration of 100 ppm produces slight nausea and irritation; concentrations of 35 ppm are practically free from irritation, though the odor is easily detectable. No cases of industrial poisoning have been reported. A fumigant. See also Ethers.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: See also Ethers.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; it reacts with water or steam to evolve toxic and corrosive fumes; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DI-2-CHLOROETHYL FORMAL

Synonym: Di-[2-chloroethyl] formal.
Description: Liquid.
Formula: $CH_2(OCH_2CH_2Cl)_2$
Constants:
Mol. Wt. 173.05
B. P. 217.5°C
Flash P. 230°F (O. C.)
Density 1.23
Vap. D. 5.9
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DICHLOROETHYL SULFIDE. See Dichlorodiethyl Sulfide.

DICHLOROFLUOROMETHANE

Synonym: "Freon 21."
Description: Heavy, colorless gas.
Formula: $HCCl_2F$
Constants:
Mol. Wt. 103
M. P. -135°C
B. P. 8.9°C
Density 1.48
Vap. Press. 2 atm @28.4°C
Vap. D. 3.82
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Inhalation 1
Chronic Local: 0
Chronic Systemic: Inhalation 1
MAC: ACGIH (accepted); 1000 parts per million in air; 4210 milligrams per cubic meter of air.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides

and fluorides.
Storage and Handling: Section 7

DICHLOROFORMOXIME
Description: Colorless, prismatic crystals, disagreeable penetrating odor.
Formula: CCl_2NOH
Constants:
Mol. Wt. 113.94
M. P. 39 - 40°C
B. P. 53 - 54°C @28 mm
Vap. D. 4.8
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DICHLOROGERMANE
Description: Colorless liquid.
Formula: GeH_2Cl_2
Constants:
Mol. Wt. 145.53
M. P. −68.0°C
B. P. 69.5°C
Density 1.90 @−68°C
Vap. D. 5.0
Toxicity: See Hydrochloric Acid and Germanium Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

1,3-DICHLORO-2,4-HEXADIENE
Description: Liquid.
Formula: $CH_2ClHCCClHCCHCH_3$
Constants:
Mol. Wt. 151.04
Flash P. 168°F (O.C.)
Vap. D. 5.2
Toxicity: See Chlorinated Hydrocarbons.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and will react with water or steam to produce toxic and corrosive fumes; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

alpha-DICHLOROHYDRIN
Description: Colorless, slightly viscous, unstable liquid, faint chloroform-like odor.
Formula: $CH_2ClCHOHCH_2Cl$
Constants:
Mol. Wt. 129.00
B. P. 174°C
Flash P. 165°F
Density 1.36 - 1.39
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

DICHLOROISOPROPYL ETHER
Description: Colorless liquid.
Formula: $(CH_2ClCH_3CH)_2O$
Constants: Mol. Wt. 171.09
B. P. 187.8°C
Freezing P. < −20°C
Flash P. 185°F (O.C.)
Density 1.11 < 25°/25°C
Vap. D. 6.0
Vap. Press. 0.10 mm @20°C
Toxicity: Details unknown. See also Ethers.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride. See also Ethers.
Explosion Hazard: Details unknown. See also Ethers.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

DICHLOROMETHANE. See Methylene Chloride.

DICHLOROMETHYL ARSINE

Synonyms: Methylarsenic dichloride; MD.
Description: Colorless liquid.
Formula: CH_3AsCl_2
Constants: Mol. Wt. 160.86
B. P. 134.5°C
Freezing P. −67°F
Flash P. Above 221°F
Density 1.838 @20°/4°C
Vap. Press. 10 mm @24.3°C
Vap. D. 5.40
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3
Toxicology: This is a blistering type of military poison. It is rapidly detoxified in the body. A moderately persistent gas. To decontaminate use bleach, DANC solution, caustic soda. Its action on the body resembles cold symptoms with headache, vomiting and nausea. Superimposed is the blistering effect of distilled mustard gas. See also Arsenic Compounds.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of chlorides and arsenic; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DICHLOROMETHYLCHLOROFORMATE

Description: Colorless liquid.
Formula: $ClCOOCHCl_2$
Constants:
Mol. Wt. 163.40
B. P. 110 - 111°C @760 mm
Density 1.56 @15°C
Vap. D. 5.63
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

2,2-DICHLORO-N-METHYL DIETHYLAMINE HYDROCHLORIDE

Synonym: Mechlorethamine hydrochloride.
Description: Crystals.
Formula: $C_5H_{11}Cl_2N \cdot HCl$
Constants:
Mol. Wt. 192
M. P. 109 - 110°C
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

DICHLOROMETHYL ETHER

Synonym: Dichlorinated methyl oxide.
Description: Volatile liquid.
Formula: $O(CH_2Cl)_2$
Constants: Mol. Wt. 115
B. P. 105°C
Density 1.315 @20°C
Vap. D. 4.0
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Details unknown. See also Ethers.
Explosion Hazard: Details unknown. See also Ethers.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

alpha, beta- DICHLOROMETHYLETHYL KETONE

Description: Liquid.
Formula: $ClCH_2COCH_2CH_2Cl$
Constants:
- Mol. Wt. 141
- B. P. 65°C @3 mm
- Vap. D. 4.9

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Disaster Control: Dangerous; when heated to decomposition, it burns and emits highly toxic fumes of chlorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DICHLOROMONOFLUOROMETHANE

See Dichlorofluoromethane.

2, 3- DICHLORO- 1, 4- NAPHTHOQUINONE

Description: Crystals.
Formula: $C_{10}H_4O_2Cl_2$
Constants: Mol. Wt. 227.1
- M. P. 193°C
- Vap. D. 7.8

Toxicity: Details unknown. See also Chlorinated Hydrocarbons, Aromatic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

1, 2, 4- DICHLORONITROBENZENE

Description: Liquid.
Formula: $C_6H_3Cl_2NO_2$
Constants:
- Mol. Wt. 192.0
- Vap. D. 6.6

Toxicity: Details unknown. See also Chlorinated Hydrocarbons, Aromatic and Nitrobenzene.
Fire Hazard: See Nitrates.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen and chlorides; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

1, 4, 2- DICHLORONITROBENZENE

Description: Liquid.
Formula: $C_6H_3Cl_2NO_2$
Constants:
- Mol. Wt. 192.0
- Vap. D. 6.6

Toxicity: Details unknown. See also Chlorinated Hydrocarbons, Aromatic and Nitrobenzene.
Fire Hazard: See Nitrates.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen and chlorides; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

1, 1- DICHLORO- 1- NITROETHANE

Description: Liquid.
Formula: $H_3CC(Cl)_2NO_2$
Constants:
- Mol. Wt. 143.96
- B. P. 124°C
- Flash P. 168°F (O. C.)
- Density 1.4153 @20°/20°C
- Vap. D. 4.97

Toxic Hazard Rating:
- Acute Local: Irritant 2; Ingestion 2; Inhalation 2
- Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption U
- Chronic Local: U
- Chronic Systemic: U

MAC: ACGIH (accepted); 10 parts per million in air; 59 milligrams per cubic meter of air.
Fire Hazard: Moderate, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of nitrogen; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

1,1-DICHLORO-1-NITROPROPANE

Description: Liquid.
Formula: $C_2H_5CCl_2NO_2$
Constants:
  Mol. Wt. 158.00
  B. P. 141°C
  Flash P. 151°F (O. C.)
  Density 1.314
  Vap. D. 5.45
Toxicity: Details unknown. See also Chlorinated Aliphatic Hydrocarbons.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of nitrogen; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

DICHLOROPENTANES (MIXED)

Description: Clear, light yellow colored liquid.
Formula: $C_5H_{10}Cl_2$
Constants:
  Mol. Wt. 141.04
  B. P. 130°C
  Flash P. 106°F (O. C.)
  Density 1.06 - 1.08 @20°C
  Autoign. Temp. 115°F
  Vap. D. 4.86
Toxicity: Details unknown. See also Chlorinated Aliphatic Hydrocarbons.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

2,4-DICHLOROPHENOL

Description: Colorless crystals.
Formula: $C_6H_3OHCl_2$
Constants:
  Mol. Wt. 163.0
  M. P. 45°C
  B. P. 210°C
  Flash P. 237°F
  Density 1.383 @60°/25°C
  Vap. Press. 1 mm @53.0°C
  Vap. D. 5.62
Toxicity: Details unknown. See also Chlorinated Hydrocarbons, Aromatic and Phenol.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, or on contact with acid or acid fumes, it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

DICHLORO-(PHENOLXENYL ETHER)

Synonym: Dichloro-(phenol diphenyl ether.
Description: Light, viscous, straw-colored liquid.
Formula: $C_{18}H_{12}OCl_2$
Constants: Mol. Wt. 315.2
  M. P. < 0°C
  B. P. 222°C @10 mm
  Flash P. 399°F
  Density 1.233 @25°/25°C
  Vap. D. 10.9
Toxicity: Details unknown. See also Chlorinated Hydrocarbons, Aromatic.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react with oxidizing materials.
Storage and Handling: Section 7

2,4-DICHLOROPHENOXYACETIC ACID

Synonym: 2,4-D.
Description: White powder.
Formula: $C_8H_6Cl_2O_3$
Constants: Mol. Wt. 221
  Vap. D. 7.63
Toxicity: Unknown
MAC: ACGIH (tentative); 10 milligrams per cubic meter of air.
Disaster Control: Dangerous; when

heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

1-(2,4-DICHLOROPHENOXY)-2-PROPANOL. See Propylene Glycol-2,4-Dichlorophenyl Ether.

alpha, alpha-DI-(4-CHLOROPHENYL) DIETHYL ETHER
Description: Crystals.
Formula: $C_{16}H_{16}O_3Cl_2$
Constants:
Mol. Wt. 327.2
Vap. D. 11.3
Toxicity: Details unknown. See also Chlorinated Hydrocarbons, Aromatic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

3,4-DICHLOROPHENYL-N-METHYL SULFONAMIDE
Description: Crystals.
Formula: $Cl_2C_7H_5O_3NS$
Constants:
Mol. Wt. 254.2
Vap. D. 6.4
Toxicity: See Chlorinated Hydrocarbons, Aromatic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur and chlorides.
Storage and Handling: Section 7

DICHLOROPHTHALIC ANHYDRIDE
Description: White flakes.
Formula: $C_6H_2Cl_2(CO)_2O$
Constants:
Mol. Wt. 217
M. P. 80 - 140°C
B. P. 220°C @40 mm
Toxicity: Details unknown; probably an irritant.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; it will react with water or steam to produce heat and toxic fumes.
Storage and Handling: Section 7

1,2-DICHLOROPROPANE
Synonym: Propylene dichloride.
Description: Colorless liquid.
Formula: $CH_2ClCHClCH_3$
Constants:
Mol. Wt. 113.0
B. P. 96.8°C
Flash P. 70°F
Density 1.1593 @20°/20°C
Vap. Press. 40 mm @19.4°C
Vap. D. 3.9
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: Irritant 1
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
MAC: ACGIH (accepted); 75 parts per million in air; 346 milligrams per cubic meter of air.
Toxicology: 1,2-Dichloropropane can cause dermatitis, and is regarded as one of the more toxic chlorinated hydrocarbons. A suggested order of increasing toxicity is: dichloromethane, trichloroethylene, carbon tetrachloride, dichloropropane, dichloroethane. Animals exposed to high concentrations of ten showed marked visceral congestion, fatty degeneration of the liver, kidney, and less frequently of the heart. They also showed areas of coagulation and necrosis of the liver. There was found to be a heavy mortality among mice exposed to 400 ppm concentrations.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

1,3-DICHLOROPROPANE
Synonym: Trimethylene chloride.
Description: Colorless liquid.
Formula: $CH_2ClCH_2CH_2Cl$
Constants:
Mol. Wt. 113.0
B. P. 125°C
Density 1.201 @15°C
Vap. D. 3.90

Toxicity: See Chlorinated Hydrocarbons, Aliphatic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene.
Storage and Handling: Section 7

2,2-DICHLOROPROPANE

Synonym: Acetone dichloride.
Description: Liquid.
Formula: $CH_3CCl_2CH_3$
Constants:
Mol. Wt. 113.0
M. P. −34.6°C
B. P. 69.7°C
Density 1.093 @20°/20°C
Vap. D. 3.9
Toxicity: See Chlorinated Hydrocarbons, Alipliatic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

1,3-DICHLOROPROPANOL-2

Description: Colorless liquid.
Formula: $CH_2ClCHOHCH_2Cl$
Constants:
Mol. Wt. 129.0
B. P. 174°C
Density 1.367 @20°/4°C
Vap. Press. 1 mm @28.0°C
Vap. D. 4.45
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Inhalation 2
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

1,3-DICHLOROPROPENE

Description: Liquid.
Formula: $C_3H_4Cl_2$
Constants:
Mol. Wt. 111.0
B. P. 103 - 110°C
Flash P. 95°F
Density 1.22
Vap. D. 3.8
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

2,3-DICHLOROPROPIONALDEHYDE

Description: Liquid.
Formula: $CHCl_2CH_2CHO$
Constants:
Mol. Wt. 127
Vap. D. 4.4
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

2,2-DICHLOROPROPIONIC ACID

Description: White to tan powder.
Formula: Cl_2CHCH_2COOH
Constant:
Mol. Wt. 143.0
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

1,2-DICHLOROPROPYLENE

Synonym: 1,2-Dichloropropene.
Description: Liquid.
Formula: $CHClCClCH_3$
Constants:
Mol. Wt. 111.0

B. P. 75°C
Vap. D. 3.83
Toxicity: See Chlorinated Hydrocarbons, Aliphatic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

2,3-DICHLOROQUINOLINE

Description: Crystals.
Formula: $C_9H_5Cl_2N$
Constants:
Mol. Wt. 198.1
M. P. 105°C
Vap. D. 6.83
Toxicity: Unknown.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

DICHLOROSTYRENE

Description: Liquid.
Formula: $C_6H_5CClCHCl$
Constants:
Mol. Wt. 173.0
Flash P. 225°F (O.C.)
Vap. D. 6.0
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

DICHLOROTETRAFLUOROETHANE

Synonym: F-114.
Description: Colorless gas.
Formula: CCl_2FCF_3
Constants:
Mol. Wt. 171
B. P. 3.5°C
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Inhalation 1
Chronic Local: U
Chronic Systemic: Inhalation 1
MAC: ACGIH (accepted); 1000 parts per million in air; 7000 milligrams per cubic meter of air.
Caution: An asphyxiant.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides and chlorides.
Storage and Handling: Section 7

beta, beta-DICHLOROVINYLCHLOROARSINE

Description: Yellow or yellowish brown liquid when pure, darker when impure.
Formula: $(ClCHCH)_2AsCl$
Constants:
Mol. Wt. 233.35
B. P. 230°C Decomposes
Density 1.702 @20°C
Vap. D. 8.05
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of arsenic and chlorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

beta, beta-DICHLOROVINYLMETHYLARSINE

Description: Liquid.
Formula: $(CHCHCl)_2CH_3As$
Constants:
Mol. Wt. 212.9
B. P. 140 - 145°C @10 mm
Vap. D. 7.35
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of arsenic and chlorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3

First Aid: Section 1
Storage and Handling: Section 7

DICOBALT OCTACARBONYL

Synonym: Cobalt tetracarbonyl.
Description: Orange crystals.
Formula: $Co_2(CO)_8$
Constants:
- Mol. Wt. 342.0
- M. P. 51°C
- B. P. Decomposes @52°C
- Density 1.73
- Vap. Press. 0.07 mm @15°C

Toxic Hazard Rating:
- Acute Local: U
- Acute Systemic: Ingestion 2; Inhalation 2
- Chronic Local: U
- Chronic Systemic: Ingestion 1; Inhalation 1

Fire Hazard: Moderate, when exposed to heat or flame. See also Carbonyls.
Explosion Hazard: Moderate, when exposed to heat or flame. See also Carbon Monoxide and Carbonyls.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

DI-meta-CRESYLTRICHLOROETHANE

Description: Crystals.
Formula: $Cl_3C_2H(C_6H_4CH_3)_2$
Constants:
- Mol. Wt. 313.7
- Vap. D. 10.8

Toxicity: Details unknown. A fungicide. See also Chlorinated Hydrocarbons, Aromatic and Cresol.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

DICYANDIAMIDE

Synonym: Cyanoguanidine.
Description: Pure white crystals.
Formula: $H_2NC(NH)NHCN$
Constants:
- Mol. Wt. 84.1
- M. P. 208°C
- Density 1.400 @25°C

Toxicity: Details unknown. See Cyanamides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of cyanides.
Storage and Handling: Section 7

ortho-DICYANOBENZENE

Synonym: 1,3-Benzene dicarbonitrile.
Description: Colorless crystals.
Formula: $C_6H_4(CN)_2$
Constants:
- Mol. Wt. 128.1
- M. P. 161°C
- B. P. Sublimes
- Vap. D. 4.42

Toxicity: An insecticide. Probably highly toxic. See also Cyanides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides; will react with water or steam to produce toxic fumes.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

para-DICYANOBENZENE

Description: Crystals.
Formula: $C_6H_4(CN)_2$
Constants:
- Mol. Wt. 128.1
- Vap. D. 4.42

Toxicity: Details unknown; a fumigant. Probably highly toxic. See also Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

DICYANOETHYLAMINE

Description: Liquid.
Formula: $C_4H_5N_3$
Constants:
- Mol. Wt. 95.1
- Vap. D. 3.3

Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

DICYANOETHYLSULFIDE

Description: Liquid.
Formula: $C_4H_3N_2S$

Constants:
Mol. Wt. 111.2
Vap. D. 3.82
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides and oxides of sulfur.
Storage and Handling: Section 7

DICYCLOHEXYL
Description: Colorless liquid; aromatic odor.
Formula: $C_6H_{11}C_6H_{11}$
Constants:
Mol. Wt. 166.3
M. P. 3°C
B. P. 238 - 239°C
Flash P. 210°F
Density 0.885 @25°/25°C
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DICYCLOHEXYLAMINE
Description: Liquid; fishy odor.
Formula: $(C_6H_{11})_2NH$
Constants:
Mol. Wt. 181.32
M. P. 20°C
B. P. 256°C
Flash P. 210°F (O.C.)
Density 0.910
Vap. D. 6.27
Toxicity: Details unknown. See Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DICYCLOHEXYL PHTHALATE
Description: White solid.
Formula: $C_6H_4(COOC_6H_{11})_2$
Constants:
Mol. Wt. 330.5
M. P. 58°C
B. P. 200 - 235°C @4 mm
Flash P. 405°F
Density 1.148 @20°/20°C
Vap. Press. 0.1 mm @150°C
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DICYCLOPENTADIENE
Description: Colorless crystals.
Formula: $C_{10}H_{12}$
Constants:
Mol. Wt. 132.2
M. P. 32.9°C
B. P. 166.6°C
Density 0.976 @35°C
Vap. Press. 10 mm @47.6°C
Vap. D. 4.55
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

DICYCLOPENTENYL ALCOHOL
Description: Liquid.
Formula: $C_{10}H_{17}O$
Constants:
Mol. Wt. 153.2
B. P. 238°C
Flash P. 426°F
Density 1.07
Vap. D. 5.3
Toxicity: Details unknown. See also Alcohols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIDECYL ADIPATE
Description: A clear liquid.
Formula: $(C_{10}H_{21}CO_2)_2C_4H_8$
Constants:
Mol. Wt. 426
B. P. 240°C @4 mm
Freezing P. -72°C
Flash P. 425°F (C.O.C.)
Density 0.916-0.922 @20°/20°C
Toxicity: See Esters, Adipic Acid.
Fire Hazard: Slight, when exposed to heat or flame; can react with

oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DI-n-DECYLAMINE
Description: Liquid.
Formula: $(C_{10}H_{21})_2NH$
Constants: Mol. Wt. 297.5
B. P. 195°C @12 mm
Vap. D. 10.3
Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

DIDECYL PHTHALATE
Description: A clear liquid.
Formula: $(C_{10}H_{21}CO_2)_2C_6H_4$
Constants:
Mol. Wt. 446
B. P. 252°C @4 mm
Freezing P. −53°C
Flash P. 450°F (C. O. C.)
Density 0.964-0.968 @20°/20°C
Toxicity: See Esters and Phthalic Acid.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIDODECYLAMINE
Description: White solid, slight ammoniacal odor.
Formula: $(C_{12}H_{25})_2NH$
Constants:
Mol. Wt. 253.7
M. P. 50°C
B. P. 210°C @1 mm
Toxicity: Details unknown. See also Amines.
Fire Hazard: Slight; on decomposition it emits toxic fumes.
Storage and Handling: Section 7

DIDYMIUM NITRATE
Description: Violet-red, hygroscopic crystals.
Composition: A mixture of praseodymium and neodymium nitrates.
Toxicity: See Nitrates.
Radiation Hazard: Didymium salts are usually slightly radioactive from the presence of thorium as an impurity (Section 5).
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

DIELDRIN
Synonym: 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-dimethanonaphthalene.
Description: Crystalline.
Formula: $C_{12}H_{10}OCl_6$
Constants:
Mol. Wt. 383
M. P. Approx. 150°C
Vap. D. 13.2
Toxicity: Unknown.
MAC: ACGIH (tentative); 0.25 milligrams per cubic meter of air.
Toxicology: Dieldrin is absorbed readily from the skin as well as through other portals. It acts as a central nervous system stimulant, but the exact mechanism of this action is entirely unknown. It also greatly reduces or eliminates appetite, apparently by an action on the central nervous system. Either nervous symptoms or anorexia may appear first. However, appetite may occasionally return in animals which are extremely sick and which eventually die.
Dangerous Acute Dose in Man: The effects of dieldrin and aldrin are similar both quantitatively and qualitatively in animals as well as in man. Persons exposed to oral dosages which exceed 10 mg/kg frequently become acutely ill. Symptoms may appear within 20 minutes and in no instance has a latent period of more than 12 hours been confirmed. No death or permanent sequelae have been reported following known poisoning by aldrin or dieldrin in man.

The oral LD_{50} of dieldrin for rats is 40-50 mg/kg indicating a toxicity roughly five times that of DDT. The dermal LD_{50} of dieldrin in xylene for rats is only slightly less than the oral toxicity (60 mg/kg for the female and 90 mg/kg for the male) indicating an acute dermal toxicity roughly 40 times that of DDT. Tests with certain other solvents indicate a factor of only six times.

Dangerous Chronic Dose: Nothing is known with certainty about the chronic toxicity of dieldrin for man. Experimental animals show a wide species variation in their susceptibility to dieldrin. Repeated dermal applications of 10 mg or even 20 mg/kg are tolerated by rats, whereas rabbits are killed by both of these dosages. Animals have shown convulsions as much as 120 days following the last dose of dieldrin indicating that dieldrin or its derivatives and/or residual toxicant-induced injury may persist in the body for a long time once severe poisoning has occurred.

Signs and Symptoms of Poisoning in Man: Early symptoms include headache, nausea, vomiting, general malaise, and dizziness. With more severe poisoning, clonic and tonic convulsions ensue or they may appear without the premonitory symptoms just mentioned. Coma may or may not follow the convulsions. Hyperexcitability and hyperirritability are common findings.

Treatment of Poisoning: Every effort should be made to remove dieldrin from the skin by thorough washing with soap and water or from the alimentary tract by the use of lavage and/or saline laxatives. Oil laxatives should be avoided. Experiments with dogs and monkeys indicate that phenobarbital is effective as an antidote. It has been necessary to give the drug in large doses over a period of 2 weeks or more. The dosage which is required to keep poisoned animals from showing hyperexcitability or convulsions and which enables them to eat and behave normally is often a dosage which would induce sleep or even anesthesia in a normal animal of the same species. In human beings the dosage should be adjusted to the symptoms.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.

Storage and Handling: Section 7

DIESEL OIL

Synonyms: Fuel Oil No. 2.

Description: Brown, slightly viscous liquid.

Constants:
Flash P. 110 - 190°F
Density Less than 1
Autoign. Temp. 494°F

Toxicity: Moderate. See Kerosene.

Fire Hazard: Moderate, when exposed to heat or flame (Section 6).

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: See Kerosene.

Disaster Control: See Kerosene.

Storage and Handling: Section 7

Shipping Regulations: Section 11.
Coast Guard Classification: Inflammable liquid.

DIETHANOLAMINE

Synonym: Di(2-hydroxyethyl) amine.

Description: A faintly colored, viscous liquid.

Formula: $(HOCH_2CH_2)_2NH$

Constants: Mol. Wt. 105.14
M. P. 28°C
B. P. 269.1°C (decomp.)
Flash P. 280°F (O. C.)
Density 1.0919 @30°/20°C
Autoign. Temp. 1224°F
Vap. Press. 5 mm @138°C
Vap. D. 3.65

Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Actue Systemic: U
Chronic Local: U
Chronic Systemic: Ingestion 1; Inhalation 1

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

Spontaneous Heating: No

To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Personal Hygiene: Section 3

Storage and Handling: Section 7

DIETHOXYCHLOROSILANE

Description: Liquid.

Formula: $(C_2H_5O)_2SiHCl$

Constants: Mol. Wt. 154.7
Vap. D. 5.33

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; will react with water or steam to produce heat, toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIETHOXYDIMETHYLSILANE

Description: Liquid.
Formula: $(C_2H_5O)_2Si(CH_3)_2$
Constants:
- Mol. Wt. 148.2
- B. P. 113.5°C
- Density 0.834
- Vap. Press. 10 mm @13.3°C
- Vap. D. 5.1

Toxic Hazard Rating:
- Acute Local: Irritant 2; Ingestion 2; Inhalation 2
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DI-ETHOXY ETHYL PHTHALATE

Description: Light-colored liquid with a mild odor.
Formula: $C_6H_4(COOC_2H_4C_2H_5)_2$
Constants:
- Mol. Wt. 310
- M. P. 31°C
- B. P. 198 - 211°C @4 mm
- Flash P. 356°F
- Density 1.12
- Vap. D. 10.7

Toxicity: Unknown.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHOXY TETRAHYDROFURAN

Description: Liquid.
Formula:
$C_2H_5OCH(CH_2)OCH(CH_2)OC_2H_5$

Constants:
- Mol. Wt. 160.21
- M. P. -26.9°C
- B. P. 173.1°C
- Flash P. 160°F (O.C.)
- Density 0.9686 @20°/20°C

Toxicity: Unknown.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYL ACETAL

Synonym: Acetal.
Description: Liquid.
Formula: $CH_3CH(OC_2H_5)_2$
Constants:
- Mol. Wt. 118.1
- M. P. -100°C
- B. P. 102.2°C
- Flash P. 55°F (O.C.)
- Density 0.8260 @20°/20°C
- Vap. D. 4.1

Toxicity: Details unknown. May have depressant effect upon ingestion or inhalation.
Fire Hazard: Dangerous, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown.
Disaster Control: Dangerous, when heated.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

DIETHYLACETAMIDE

Description: Liquid.
Formula: $(C_2H_5)_2CHCONH_2$
Constants:
- Mol. Wt. 115.2
- M. P. < -65°C
- B. P. 180°C
- Flash P. 170°F
- Density 0.92
- Vap. D. 4.0

Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

DIETHYLAMINE

Description: Colorless liquid, ammoniacal odor.
Formula: $(C_2H_5)_2NH$
Constants: Mol. Wt. 73.1
M. P. -38.9°C
B. P. 55.5°C
Flash P. Below 0°F
Density 0.7108 @20°/20°C
Autoign. Temp. 594°F
Vap. Press. 400 mm @38.0°C
Vap. D. 2.53
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (accepted); 25 parts per million in air; 75 milligrams per cubic meter of air.
Fire Hazard: Dangerous, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous when heated.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

DIETHYLAMINOETHANOL

Description: Liquid.
Formula: $(C_2H_5)_2NCH_2CH_2OH$
Constants: Mol. Wt. 117.19
B. P. 161°C
Flash P. 140°F (O.C.)
Density 0.885
Vap. D. 4.03
Toxicity: Details unknown. See also Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride.
Storage and Handling: Section 7

3-DIETHYLAMINOPROPYLAMINE

Description: Liquid.
Formula: $(C_2H_5)_2N\text{-}NH(C_3H_7)$
Constants:
Mol. Wt. 130.3
B. P. 165 - 170°C
Flash P. 125°F
Density 0.82
Vap. D. 4.48
Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYLANILINE

Description: Colorless to yellow liquid.
Formula: $(C_2H_5)_2NC_6H_5$
Constants:
Mol. Wt. 149.23
M. P. -38°C
Flash P. 220°F
B. P. 215.5°C
Density 0.9351
Vap. Press. 1 mm @49.7°C
Vap. D. 5.15
Toxicity: Details unknown. See also Aniline.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes and can react with oxidizing materials.
Storage and Handling: Section 7

1,4-DIETHYLBENZENE (MIXTURE OF ISOMERS)

Description: Colorless, mobile liquid.
Formula: $C_6H_4(C_2H_5)_2$

Constants: Mol. Wt. 134.21
M. P. -35°C
B. P. 183.8°C
Freezing P. < -70°C
Flash P. 132°F
Density 0.868 @25°/25°C
Autoign. Temp. 806°F
Vap. Press. 1 mm @20.7°C
Vap. D. 4.62
Toxicity: Details unknown. See also Benzene and Ethyl Benzene.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYLBERYLLIUM

Description: Colorless liquid.
Formula: $Be(C_2H_5)_2$
Constants:
Mol. Wt. 67.14
M. P. 12°C
B. P. 110°C @15 mm
Vap. D. 2.3
Toxicity: See Beryllium Compounds.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of beryllium; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

DI(2-ETHYL BUTYL) AZELATE

Description: Liquid.
Formula: $(CH_2)_7(CO_2C_6H_{13})_2$
Constants:
Mol. Wt. 356.5
Flash P. 385°F
Density 0.93
Vap. D. 12.3
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DI-(2-ETHYL BUTYL) PHTHALATE

Description: Clear, oily, slightly aromatic liquid.
Formula: $C_6H_4[COOCH_2CH(C_2H_5)_2]_2$
Constants:
Mol. Wt. 334
M. P. -50°C
B. P. 350°C
Flash P. 381°F
Density 1.01-1.016 @20°/20°C
Vap. D. 11.5
Toxicity: Details unknown. See also Esters.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYL CARBAMYL CHLORIDE

Description: Liquid.
Formula: $(C_2H_5)_2NCOCl$
Constants:
Mol. Wt. 119.6
M. P. -44°C
B. P. 190 - 195°C
Vap. D. 4.1
Toxicity: Details unknown. Probably toxic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

N, N'-DIETHYLCARBANILIDE

Synonym: N, N'-Diethyl-N, N'-diphenyl urea.
Description: Colorless crystals.
Formula: $CO[N(C_2H_5)(C_6H_5)]_2$
Constants:
Mol. Wt. 268.4
M. P. 73°C
Vap. D. 9.3
Toxicity: Unknown
Explosion Hazard: Severe, when shocked or exposed to heat (Section 7).
Disaster Control: Highly dangerous; shock and heat will explode it; when heated to decomposition, it emits highly toxic fumes.
Storage and Handling: Section 7

DIETHYL CARBINOL. See sec-Amyl Alcohol.

DIETHYL "CARBITOL"

Synonym: Diethylene glycol monoethyl ether.

Description: Colorless, nearly odorless liquid.
Formula: $C_6H_{14}O_3$
Constants: Mol. Wt. 134.17
B. P. 201.9°C
Flash P. 180°F (O.C.)
Density 0.9082 @20°/20°C
Vap. D. 5.6
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2
Chronic Local: U
Chronic Systemic: Ingestion 1; Inhalation 1
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride; can react with oxidizing materials (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIETHYL CARBONATE
Synonyms: Ethyl carbonate; carbonic ether.
Description: Colorless liquid, mild odor.
Formula: $(C_2H_5)_2CO_3$
Constants: Mol. Wt. 118.13
M. P. -43°C
B. P. 125.8°C
Flash P. 89°F (O.C.)
Density 0.975 @20°/4°C
Vap. Press. 10 mm @23.8°C
Vap. D. 4.07
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous when heated.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIETHYL "CELLOSOLVE"
Synonym: 1,2-Diethoxy ethylene.
Description: Colorless liquid, slight ethereal odor.
Formula: $C_2H_5OCH_2CH_2OC_2H_5$
Constants: Mol. Wt. 119.17
M. P. -74°C
B. P. 121.4°C
Flash P. 95°F (O.C.)
Density 0.8417 @20°/20°C
Autoign. Temp. 406°F
Vap. D. 6.56
Vap. Press. 9.4 mm
Toxicity: Details unknown. See also Glycols and "Cellosolves".
Fire Hazard: Moderately dangerous, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

DIETHYL beta-CHLOROETHYLAMINE
Description: Liquid.
Formula: $(C_2H_5)_2NC_2H_4Cl$
Constants:
Mol. Wt. 135.64
Vap. D. 4.69
Toxicity: Details unknown. See also Amines.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

DIETHYL CHLOROPHOSPHATE
Description: Water-white liquid.
Formula: $(C_2H_5O)_2POCl$
Constants:
Mol. Wt. 172
B. P. 60°C @2 mm
Density 1.1915 @25°/25°C
Vap. D. 5.94
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of phosphorus.
Storage and Handling: Section 7

DIETHYL CYANAMIDE
Synonym: N-cyanodiethylamine.
Description: Liquid.
Formula: $CNN(C_2H_5)_2$

Constants:
Mol. Wt. 98.15
M. P. −80.5°C
B. P. 186°C
Flash P. 176°F
Density 0.8591 @30°C
Vap. D. 3.4
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides; will react with water or steam to produce toxic and corrosive fumes; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

N, N-DIETHYL CYCLOHEXYLAMINE
Description: Clear, colorless liquid.
Formula: $(C_2H_5)_2N(C_6H_{11})$
Constants:
Mol. Wt. 155.3
B. P. 194.5°C
Vap. D. 5.36
Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYL DICHLOROSILANE
Synonym: Dichlorodiethylsilane.
Description: Liquid.
Formula: $C_4H_{10}Cl_2Si$
Constants:
Mol. Wt. 157.05
M. P. −96°C
B. P. 131.0°C
Flash P. 70°F
Density 1.05
Vap. D. 5.41
Toxicity: See Chlorosilanes.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and will react with water or steam to produce heat, toxic and corrosive fumes; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid - No exemptions; white label.
Coast Guard Classification: Corrosive liquid; white label.

DIETHYL DIPHENYL UREA
Description: Liquid.
Formula: $[(C_2H_5)(C_6H_5)N]_2CO$
Constants:
Mol. Wt. 268.35
M. P. 71°C
B. P. 326°C
Flash P. 302°F (C.C.)
Density 1.12
Vap. D. 9.3
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

DIETHYLENE DIOXIDE. See Dioxan.

DIETHYLENE GLYCOL
Synonym: Diglycol.
Description: Clear, colorless, practically odorless, syrupy liquid.
Formula: $CH_2OHCH_2OCH_2CH_2OH$
Constants:
Mol. Wt. 106.12
B. P. 245.8°C

Freezing P. −8°C
Flash P. 275°F (O.C.)
Density 1.1184 @20°/20°C
Autoign. Temp. 444°F
Vap. Press. 1 mm @91.8°C
Vap. D. 3.66
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 0; Inhalation 0
Acute Systemic: Ingestion 2
Chronic Local: Irritant 1
Chronic Systemic: Ingestion 1; Inhalation 1
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIETHYLENE GLYCOL n-BUTYL ETHER

Description: Clear, mobile liquid, pleasant odor.
Formula: $C_4H_9(OCH_2CH_2)_2OH$
Constants:
Mol. Wt. 162.2
B. P. 226.7 - 230.4°C
Freezing P. −76°C (supercools)
Flash P. 225°F (C.O.C.)
Density 0.9546 @20°/20°C
Vap. Press. 30 mm @130°C
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYLENE GLYCOL CHLOROHYDRIN

Description: Water-white liquid.
Formula: $ClCH_2CH_2OCH_2CH_2OH$
Constants:
Mol. Wt. 124.57
M. P. −90°C (sets to a glass)
B. P. 198.9°C
Flash P. 437°F
Density 1.1753 @20°/20°C
Vap. D. 4.3
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and can react with oxidizing materials.
Storage and Handling: Section 7

DIETHYLENE GLYCOL DIABIETATE (20% XYLENE)

Synonym: Diglycol diabietate.
Description: Liquid mixture.
Formula: $(C_{19}H_3COOCH_2CH_2)_2O$
Constants:
Mol. Wt. 622.6
Flash P. 97°F
Toxicity: Details unknown. See also Xylene and Glycols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6). See also Xylene.
Storage and Handling: Section 7

DIETHYLENE GLYCOL DIACETATE

Synonym: Diglycol diacetate.
Description: Colorless liquid.
Formula: $(CH_3COOCH_2CH_2)_2O$
Constants: Mol. Wt. 190.20
M. P. 19.1°C
B. P. 250°C
Flash P. 255°F
Density 1.1159 @20°/20°C
Vap. D. 6.56
Vap. Press. 0.02 mm @20°C
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYLENE GLYCOL DIBENZOATE

Description: Liquid.
Formula:
$C_6H_5COOCH_2CH_2OCH_2CH_2OCOC_6H_5$
Constants:
Mol. Wt. 314.32
M. P. 15.9°C
B. P. 236°C @5 mm
Flash P. 555°F

Density 1.1765 @20°/20°C
Vap. Press. 0.89 mm @200°C
Toxicity: See Esters, Glycols and Benzoic Acid.
Fire Hazards: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYLENE GLYCOL DI-2-ETHYL BENZOATE

Description: Liquid.
Formula:
$C_6H_5COOCH_2CH_2OCH_2CH_2OCOC_6H_5$
Constants:
Mol. Wt. 290.30
M. P. 15.9°C
B. P. 236°C @5 mm
Flash P. 455°F (O.C.)
Density 1.1765 @20°/20°C
Vap. D. 10.0
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYLENE GLYCOL DIGLYCOLATE

Description: Yellow liquid, faint odor.
Formula: $(CH_2CH_2OOCCH_2OH)_2O$
Constants:
Mol. Wt. 222.2
Density 1.30 @30°C
Vap. D. 7.65
Toxicity: See Glycols.
Fire Hazard: Slight, when heated, it emits acrid fumes.
Storage and Handling: Section 7

DIETHYLENE GLYCOL DILEVULINATE

Description: Amber liquid, pleasant odor.
Formula:
$(CH_2CH_2OOC(CH_2)_2COCH_3)_2O$
Constants:
Mol. Wt. 270.4
Flash P. 340°F (C.C.)
Density 1.145 @25°C
Vap. D. 9.33
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYLENE GLYCOL DIMETHYL ETHER

Description: Liquid.
Formula: $CH_3O(CH_2CH_2O)_2CH_3$
Constants:
Mol. Wt. 134.17
B. P. 162°C
M. P. < -75°C
Flash P. 158°F (O.C.)
Density 0.9440 @20°C
Vap. D. 4.62
Toxicity: Details unknown. See also Ethers and Glycols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Details unknown. See also Ethers.
Storage and Handling: Section 7

DIETHYLENE GLYCOL DINITRATE

Synonym: Dinitroglycol.
Description: Liquid.
Formula: $C_4H_8O_3(NO_2)_2$
Constants:
Mol. Wt. 196.1
Vap. D. 6.76
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2
Chronic Local: U
Chronic Systemic: Inhalation 1
Caution: This compound can cause a drop in blood pressure. See also Glycols and Nitrates.
Fire Hazard: See Nitrates and Explosives, High.
Explosion Hazard: Severe, when shocked or exposed to heat. Used in low freezing dynamites and some permissible explosives. See also Explosives, High.
Disaster Control: Dangerous; shock and heat will explode it; when heated, it emits toxic fumes of oxides of nitrogen; can react

vigorously with oxidizing or reducing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Prohibited.

DIETHYLENE GLYCOL DIOLEATE

Description: Pale yellow liquid.
Formula: $(C_{17}H_{33}CO_2C_2H_4)_2O$
Constants:
Mol. Wt. 635.0
Density 0.9310 @20°/4°C
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

DIETHYLENE GLYCOL DIPELARGONATE

Description: Liquid.
Formula: $CH_3(CH_2)_7COOCH_2CH_2OCH_2CH_2OOC(CH_2)_7CH_3$
Constants:
Mol. Wt. 362
M. P. -15°C
B. P. 229°C @5 mm
Flash P. 410°F
Density 0.966 @20°C
Vap. D. 12.5
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYLENE GLYCOL ETHYL ETHER

Description: A clear colorless liquid; mild odor.
Formula: $C_2H_5(OCH_2CH_2)_2OH$
Constants:
Mol. Wt. 134.2
B. P. 200 - 202°C
Flash P. 205°F (C.O.C.)
Density 0.9855 @25°/25°C
Vap. Press. 10 mm @90°C
Toxicity: Details unknown.
Caution: Avoid excessive breathing vapor.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemicals or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYLENE GLYCOL LAURATE

Synonym: Diglycol laurate.
Description: Light straw-colored, oily liquid.
Formula:
$HOCH_2CH_2OCH_2CH_2OOC(CH_2)_{10}CH_3$
Constants:
Mol. Wt. 288.4
M. P. 17°C
B. P. 315 - 325°C
Flash P. 290°F
Density 0.965-0.975
Vap. D. 10.0
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYLENE GLYCOL METHYL ETHER

Description: Colorless liquid.
Formula: $CH_3(OC_2H_4)_2OH$
Constants:
Mol. Wt. 120.1
B. P. 193.5°C
Flash P. 210°F
Density 1.018 @25°/25°C
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYLENE GLYCOL MONOBUTYL ETHER ACETATE

Toxicity: Details unknown; mosquito repellent. See also Glycols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Storage and Handling: Section 7

DIETHYLENE GLYCOL MONOETHYL ETHER. See "Carbitol."

DIETHYLENE GLYCOL MONOLAURATE

Description: Light yellow, oily liquid.
Formula: $C_{11}H_{23}COOC_2H_4OC_2H_4OH$
Constants:
Mol. Wt. 288.42
M. P. 16 - 19°C
B. P. > 280°C
Density 0.97 @25°C
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Storage and Handling: Section 7

DIETHYLENE GLYCOL MONOMETHYL ETHER. See Methyl "Carbitol."

DIETHYLENE GLYCOL MONOMETHYL ETHER ACETATE. See Methyl "Carbitol" Acetate.

DIETHYLENE GLYCOL MONOPHENYL ETHER. See Phenyl "Carbitol."

DIETHYLENE GLYCOL MYRISTATE

Synonym: Diglycol myristate.
Description: Light colored wax; faint odor.
Formula: $HOCH_2CH_2OCH_2CH_2OOC(CH_2)_{12}CH_3$
Constants:
Mol. Wt. 316.5
M. P. 37°C
Flash P. 290°F
Density 0.938 @38°C
Vap. D. 10.9
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYLENE OXIDE. See Dioxan.

DIETHYLENETRIAMINE

Description: Yellow, viscous liquid; mild ammoniacal odor.
Formula: $(NH_2C_2H_4)_2NH$
Constants: Mol. Wt. 103.17
M. P. -39°C
B. P. 207°C
Flash P. 215°F (O. C.)
Density 0.9586 @20°/20°C
Autoign. Temp. 750°F
Vap. Press 0.22 mm @20°C
Vap. D. 3.48
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11
MCA warning label.

DIETHYL ETHANOLAMINE

Synonym: Diethyl amino ethanol.
Description: Colorless, hygroscopic liquid.
Formula: $(C_2H_5)_2NCH_2CH_2OH$
Constants:
Mol. Wt. 117.2
B. P. 162°C
Flash P. 140°F (O. C.)
Density 0.8851 @20°/20°C
Vap. Press. 1.4 mm @20°C
Vap. D. 4.03
Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYL ETHER. See Ethyl Ether.

DIETHYL ETHOXY METHYLENE MALONATE

Description: Liquid.
Formula: $C_2H_5OCH = C(COOC_2H_5)_2$
Constants:
Mol. Wt. 217
Vap. D. 7.48
Toxicity: Details unknown.
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

DIETHYL ETHYLENE BIS-GLYCOLATE

Description: Liquid.
Formula: $(CH_2OCH_2CO_2C_2H_5)_2$
Constants:
Mol. Wt. 234.2
B. P. 152 - 155°C @5 mm
Flash P. 255°F (O.C.)
Density 1.1199 @25°/25°C
Vap. D. 8.09
Toxicity: Details unknown. See also Esters and Ethyl Alcohol.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

N,N-DIETHYL ETHYLENE DIAMINE

Description: Liquid.
Formula: $(C_2H_5)_2NC_2H_4NH_2$
Constants:
Mol. Wt. 116.2
B. P. 60°C @40 mm
Flash P. 115°F (O.C.)
Density 0.82 @20°/20°C
Vap. D. 4.00
Toxicity: Details unknown.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYL ETHYL PHOSPHONATE

Description: Colorless liquid; sweet odor.
Formula: $C_2H_5P(O)(OC_2H_5)_2$
Constants:
Mol. Wt. 166.2
B. P. 83°C @11 mm
Flash P. 221°F (C.O.C.)
Density 1.025 @20°/4°C
Vap. D. 5.73
Toxicity: Details unknown.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of oxides of phosphorus; can react with oxidizing materials.
Storage and Handling: Section 7

DIETHYL FLUOROPHOSPHATE

Description: A liquid with a sweet or fruity odor.
Formula: $(C_2H_5O)_2POF$
Constants:
Mol. Wt. 156.10
M. P. Low
B. P. 170°C
Density 1.15 (approx.)
Vap. D. 5.38
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of fluorides and oxides of phosphorus.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DIETHYL FUMARATE

Description: White crystals or liquid.
Formula: $C_2H_5OCOCHCHCOOC_2H_5$
Constants:
Mol. Wt. 172.2
M. P. 0.6°C
B. P. 218.5°C
Flash P. 220°F
Density 1.0529 @20°/20°C
Vap. Press. 1 mm @53.2°C
Vap. D. 5.93
Toxicity: See Esters, Fumaric Acid and Ethyl Alcohol.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYL GLYCOCOLL-p-AMINO o-OXYBENZOIC METHYL ESTER

Description: Colorless, prismatic crystals.

Formula:
$C_6H_3OHCOOCH_3NHCOCH_2N(C_2H_5)_2$
Constants:
Mol. Wt. 280.3
M. P. 185°C
Vap. D. 9.65
Toxicity: Details unknown. See also Esters.
Fire Hazard: Slight; when heated, it emits smoke (Section 6).
Storage and Handling: Section 7

DIETHYL GLYCOCOLLGUAIACOL HYDROCHLORIDE

Description: White prisms.
Formula:
$CH_3OC_6H_4OCOCH_2N(C_2H_5)_2 \cdot HCl$
Constants:
Mol. Wt. 273.70
Vap. D. 9.45
Toxicity: Details unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of hydrogen chloride.
Storage and Handling: Section 7

DIETHYL GLYCOL PHTHALATE

Description: Liquid.
Formula: $C_6H_4[COO(CH_2)_2OC_2H_5]_2$
Constants:
Mol. Wt. 310.34
Flash P. 343°F
Density 1.11
Toxicity: Details unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DI-(2-ETHYLHEXYL) ADIPATE

Description: Liquid.
Formula: $C_4H_9(C_2H_5)CHCH_2OCOC_4H_8$-$COOCH_2CH(C_2H_5)C_4H_9$
Constants:
Mol. Wt. 370.56
M. P. -60°C
B. P. 214°C @5 mm
Flash P. 385°F
Density 0.9268 @20°/20°C
Vap. Press. 2.6 mm @200°C
Vap. D. 12.8
Toxicity: See Esters, Adipic Acid and Ethyl Hexanol.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DI-2-ETHYLHEXYLAMINE

Synonym: Dioctyl amine.
Description: Water-white liquid with slightly ammoniacal odor.
Formula: $[C_4H_9CH(C_2H_5)CH_2]_2NH$
Constants:
Mol. Wt. 241.45
B. P. 281.1°C
Flash P. 270°F (O.C.)
Density 0.8062 @20°/20°C
Vap. D. 8.35
Toxicity: Details unknown. See also Amines.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DI-2-ETHYLHEXYL AZELATE

Description: Liquid.
Formula: $C_{25}H_{48}O_4$
Constants:
Mol. Wt. 412.63
M. P. -67.8°C
B. P. 237°C @5 mm
Flash P. 415°F
Density 0.918 @20°C
Vap. D. 18.7
Toxicity: Details unknown. See also Esters.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DI(2-ETHYL HEXYL) ETHANOLAMINE

Description: Liquid.
Formula: $[C_4H_9CH(C_2H_5)CH_2]_2NC_2H_4OH$
Constants:
Mol. Wt. 285.5
M. P. -60°C
B. P. 216°C @50 mm
Flash P. 280°F (O.C.)
Density 0.8573 @20°/20°C
Vap. Press. < 0.01 mm @20°C
Vap. D. 9.87
Toxicity: Details unknown. See

also Amines.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DI-2-ETHYLHEXYLETHYLENE BIS-GLYCOLATE

Description: Liquid.
Formula: $(CH_2OCH_2CO_2C_8H_{17})_2$
Constants:
- Mol. Wt. 402.6
- B. P. 192 - 202°C @0.3 mm
- Flash P. 390°F (O.C.)
- Density 0.9760 @25°/25°C
- Vap. D. 13.9

Toxicity: Details unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DI-(2-ETHYLHEXYL) HEXAHYDROPHTHALATE

Description: Liquid.
Formula: $C_6H_{10}[COOCH_2CH(C_2H_5)C_4H_9]_2$
Constants:
- Mol. Wt. 396.59
- M. P. -53°C
- B. P. 216°C @5 mm
- Flash P. 425°F
- Density 0.9586 @20°/20°C
- Vap. Press. 2.2 mm @200°C
- Vap. D. 13.7

Toxicity: Details unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DI(ETHYLHEXYL) MALEATE

Description: Liquid.
Formula: $[CHCO_2CH_2CH(C_2H_5)C_4H_9]_2$
Constants:
- Mol. Wt. 340.5
- M. P. -60°C
- B. P. 164°C @10 mm
- Flash P. 365°F
- Density 0.9436 @20°/20°C
- Vap. D. 11.7

Toxicity: Details unknown. See also Esters.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Storage and Handling: Section 7

DI-2-ETHYLHEXYL PHOSPHITE

Description: Liquid.
Formula: $(C_8H_{17}O)_2PHO$
Constants:
- Mol. Wt. 306
- B. P. 150 - 155°C @2-3 mm
- Density 0.929 @25°/4°C
- Vap. D. 10.6

Toxicity: Details unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus.
Storage and Handling: Section 7

DI-2-ETHYLHEXYLPHTHALATE

Synonym: Dioctyl phthalate.
Description: Stable, light colored liquid; mild odor.
Formula: $C_6H_4[CO_2CH_2CH(C_2H_5)C_4H_9]_2$
Constants:
- Mol. Wt. 390.6
- B. P. 230°C @5 mm
- Freezing P. -55°C
- Flash P. 425°F (O.C.)
- Density 0.9861 @20°/20°C
- Vap. Press. 1.2 mm @200°C
- Vap. D. 16.0

Toxicity: Details unknown. See also Esters.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DI-2-ETHYLHEXYL SEBACATE

Description: Light, clear liquid; mild odor.
Formula: $(CH_2)_8(CO_2C_8H_{17})_2$
Constants:
- Mol. Wt. 426
- B. P. 248°C @9 mm
- Freezing P. -55°C
- Flash P. 410°F
- Density 0.913 @25°/25°C
- Vap. D. 14.7

Toxicity: See Esters and Ethyl Hexyl Alcohol.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DI(2-ETHYLHEXYL) SUCCINATE

Description: Liquid.
Formula: $C_8H_{17}OCOCH_2CH_2COOC_8H_{17}$
Constants:
Mol. Wt. 342.5
M. P. -60°C
B. P. 257°C @50 mm
Flash P. 315°F (O. C.)
Density 0.9346 @20°/20°C
Vap. D. 11.8
Toxicity: Details unknown. See also Esters.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DI-2-ETHYLHEXYLTETRAHYDROPHTHALATE

Description: Liquid.
Formula:
$C_6H_8[COOCH_2CH(C_2H_5)C_4H_9]_2$
Constants:
Mol. Wt. 394.58
M. P. -50°C
B. P. 219°C @5 mm
Flash P. 350°F (O. C.)
Density 0.9685 @20°/20°C
Vap. D. 13.6
Toxicity: Details unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYL KETONE

Synonyms: 3-Pentanone; metacetone; propione; ethyl propionyl.
Description: Colorless, mobile liquid; acetone-like odor.
Formula: $C_2H_5COC_2H_5$
Constants:
Mol. Wt. 86.13
M. P. -42°C
B. P. 101°C
Flash P. 55°F
Density 0.8159 @19°/4°C
Vap. D. 2.96
Toxicity: Details unknown. See also Ketones.
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

DIETHYLLAURAMIDE

Description: Liquid.
Formula: $(C_2H_5)_2NOC(CH_2)_{10}CH_3$
Constants:
Mol. Wt. 255
B. P. 165°C
Flash P. 150°F
Density 0.86
Vap. D. 9.35
Toxicity: Details unknown
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react with oxidizing materials.
Storage and Handling: Section 7

DIETHYL MALEATE

Description: Water-white liquid.
Formula: $(HCCOOC_2H_5)_2$
Constants:
Mol. Wt. 172.2
M. P. -11.5°C
B. P. 225.0°C
Flash P. 200°F
Density 1.0687 @20°C
Vap. Press. 1 mm @57.3°C
Vap. D. 5.93
Toxicity: See Esters, Ethyl Alcohol and Maleic Acid.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon

tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYL MALONATE

Synonym: Ethyl malonate.
Description: Clear, colorless liquid.
Formula: $CH_2(COOC_2H_5)_2$
Constants:
Mol. Wt. 160.17
B. P. 198.9°C
Freezing P. −49.8°C
Flash P. 200°F (O.C.)
Density 1.055 @25°/25°C
Vap. Press. 1 mm @40.0°C
Vap. D. 5.52
Toxicity: See Esters and Ethyl Alcohol.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYL MERCURY

Description: Colorless liquid; hazel-like odor.
Formula: $Hg(C_2H_5)_2$
Constants:
Mol. Wt. 258.73
B. P. 159°C
Density 2.4660 @20°C
Toxicity: Highly toxic. See Mercury Compounds.
Fire Hazard: Moderate, when exposed to heat or flame.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of mercury; can react with oxidizing materials.
Storage and Handling: Section 7

DIETHYL METHYL METHANE

Synonym: 3-Methylpentane.
Description: Liquid.
Formula: C_6H_{14}
Constants:
Mol. Wt. 86.2
B. P. 64°C
Flash P. 80°F
Density 0.67
Vap. D. 2.97
Toxicity: Details unknown
Fire Hazard: Dangerous; when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

O,O-DIETHYL-O,p-NITRO-PHENYL THIOPHOSPHATE. See Parathion.

DIETHYL OXALATE

Synonyms: Ethyl ethanedioate; oxalic ether.
Description: Colorless liquid.
Formula: $(COOC_2H_5)_2$
Constants: Mol. Wt. 146.14
M. P. 40.6°C
B. P. 185.4°C
Freezing P. −41.6°C
Flash P. 168°F (C.C.)
Density 1.0705 @20°/20°C
Vap. Press. 1 mm @47.4°C
Vap. D. 5.03
Toxicity: See Esters, Ethyl Alcohol and Oxalic Acid.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

3,3-DIETHYL PENTANE

Description: Liquid.
Formula: $CH_3CH_2C(C_2H_5)_2CH_2CH_3$
Constants:
Mol. Wt. 128.3
Autoign. Temp. 612°F
Vap. D. 4.42
Toxicity: Details unknown
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use moderate rate).

DIETHYL PHOSPHINE

Description: Colorless liquid.
Formula: $(C_2H_5)_2PH$
Constants:
Mol. Wt. 90.1

B. P. 85°C
Density < 1
Vap. D. 3.11
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3
Fire Hazard: Dangerous, when exposed to heat or flame; may be spontaneously flammable in air.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DIETHYL PHOSPHITE
Description: Liquid.
Formula: $(C_2H_5O)_2PHO$
Constants:
Mol. Wt. 138
B. P. 138°C
Density 1.071 @20°/20°C
Vap. D. 4.76
Toxicity: Details unknown.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus; can react with oxidizing materials.
Storage and Handling: Section 7

DIETHYL o-PHTHALATE
Synonym: Ethyl phthalate.
Description: Clear, colorless liquid.
Formula: $C_6H_4(CO_2C_2H_5)_2$
Constants: Mol. Wt. 222.2
M. P. -40.5°C
B. P. 302°C
Flash P. 243°F (C.C.)
Density 1.110
Vap. D. 7.66
Toxicity: See Esters, Ethyl Alcohol, ortho-Phthalic Acid.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYL p-PHTHALATE
Description: Liquid.
Formula: $C_6H_4(COOC_2H_5)_2$
Constants:
Mol. Wt. 222.23
M. P. -5°C
B. P. 296°C
Flash P. 325°F O.C.)
Density 1.117-1.121 @20°/20°C
Vap. D. 7.66
Toxicity: See Esters, Ethyl Alcohol, para-Phthalic Acid.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

N,N-DIETHYL PIPERONYLAMIDE
Description: Crystals.
Formula:
$CH_2O_2:C_6H_3 \cdot CON(C_2H_5)_2$
Constants:
Mol. Wt. 237.25
Vap. D. 9.44
Toxicity: Details unknown, but piperonyl compounds are generally of a low order of toxicity; an insecticide.
Fire Hazard: Slight; when heated, it emits toxic fumes.
Storage and Handling: Section 7

2,2-DIETHYL-1,3-PROPANEDIOL
Description: Crystals.
Formula: $HOCH_2C(C_2H_5)_2CH_2OH$
Constants:
Mol. Wt. 132.2
B. P. 125°C @10 mm
Freezing P. 61.3°C
Flash P. 215°F (O.C.)
Density 1.052 @20°C
Toxicity: Details unknown.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYL SELENIDE

Description: Liquid.
Formula: $(C_2H_5)_2Se$
Constants:
  Mol. Wt. 137.08
  B. P. 108.0°C
  Density 1.23
  Vap. Press. 40 mm @31.2°C
  Vap. D. 4.73
Toxicity: See Selenium and its Compounds.
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 2.5% (L.E.L.)
Disaster Control: See Selenium and its Compounds.
Storage and Handling: Section 7

DIETHYL STEARAMIDE

Description: Liquid.
Formula: $(C_2H_5)_2NOC(CH_2)_{16}CH_3$
Constants:
  Mol. Wt. 339.6
  B. P. 140°C
  Flash P. 375°F
  Density 0.86
  Vap. D. 11.7
Toxicity: Unknown
Fire Hazard: Slight; when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYL STILBESTROL

Synonym: Stilbestrol.
Description: Small crystals.
Formula: $C_{18}H_{20}O_2$
Constants:
  Mol. Wt. 268.3
  M. P. 169 - 172°C
Toxic Hazard Rating:
  Acute Local: Irritant 2; Allergen 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Fire Hazard: Slight; when heated, it emits acrid fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIETHYLSTILBESTROL DIPROPIONATE

Description: Crystals.
Formula: $C_{24}H_{28}O_4$
Constants:
  Mol. Wt. 380.4
  M. P. 104°C
Toxicity: See Diethyl Stibestrol.
Fire Hazard: Slight; when heated, it emits smoke (Section 6).
Storage and Handling: Section 7

DIETHYL SUCCINATE

Synonym: Ethyl succinate.
Description: Essentially colorless, clear, mobile liquid; slight odor.
Formula: $C_8H_{14}O_4$
Constants:
  Mol. Wt. 174.2
  M. P. -20.8°C
  B. P. 216.5°C
  Flash P. 230°F (O.C.)
  Density 1.037 @25°/25°C
  Vap. Press. 1 mm @54.6°C
  Vap. D. 6.0
Toxicity: Probably very low. See also Succinic Acid.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIETHYL SULFATE

Synonym: Ethyl sulfate.
Description: Colorless, oily liquid; faint ethereal odor.
Formula: $(C_2H_5)_2SO_4$
Constants:
  Mol. Wt. 154.18
  M. P. -25.0°C
  B. P. 209.5°C
  Flash P. 220°F (C.C.)
  Density 1.172 @25°/4°C
  Autoign. Temp. 817°F
  Vap. Press. 1 mm @47.0°C
  Vap. D. 5.31
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U

Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of sulfur; it can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIETHYLTHIOCARBAMYL CHLORIDE
Description: Crystals.
Formula: $(C_2H_5)_2NC(S)Cl$
Constants:
Mol. Wt. 151.7
M. P. 46.2°C
B. P. 97 - 103°C @5 mm
Toxicity: Probably high. See Chlorides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of chlorides and oxides of sulfur.
Storage and Handling: Section 7

1,1,1-DIFLUOROCHLOROETHANE. See Difluoromonochloroethane.

DIFLUOROCHLOROMETHYL METHANE. See Difluorochloroethane.

DIFLUORODIBROMOMETHANE. See Dibromodifluoromethane.

DIFLUORODIPHENYL DISULFIDE
Description: Crystals.
Formula: $C_{12}H_6S_2F_2$
Constants: Mol. Wt. 252.3
Vap. D. 8.72
Toxicity: An insecticide. See also Fluorides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of fluorides and oxides of sulfur; it will react with water or steam to produce toxic fumes.
Storage and Handling: Section 7

DIFLUORODIPHENYL TRICHLOROETHANE
Description: Crystals.
Formula: $C_{14}H_9Cl_3F_2$
Constants: Mol. Wt. 321.5
M. P. 45.5°C
Vap. D. 10.9
Toxicity: See Fluorides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides and chlorides.
Storage and Handling: Section 7

1,1-DIFLUOROETHANE
Synonyms: Difluoroethane; ethylene fluoride.
Description: A colorless gas or liquid.
Formula: $F_2C_2H_4$
Constants:
Mol. Wt. 66.1
M. P. -117.0°C
B. P. -26.5°C
Density 1.004 @25°C
Vap. D. 2.28
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Inhalation 1
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of fluorides; it can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable gas; red gas label.
Coast Guard Classification: Inflammable gas; red gas label.

1,1-DIFLUOROETHYLENE
Description: Colorless gas.
Formula: CH_2CF_2
Constants:
Mol. Wt. 64.04
B. P. Below -70°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Inhalation 1
Chronic Local: U
Chronic Systemic: U

Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of fluorides.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

DIFLUOROMONOCHLOROETHANE

Synonym: 1, 1, 1, -Difluorochloroethane.
Description: Gas.
Formula: $C_2H_3F_2Cl$
Constants:
  Mol. Wt. 100.5
  M. P. -131°C
  B. P. -9.5°C
  Density 1.19
Toxicity Hazard Ratings:
  Acute Local: U
  Acute Systemic: Inhalation 1
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of fluorides and chlorides; can react vigorously with oxidizing materials.
Ventialtion Control: (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable gas; red gas label.
  Coast Guard Classification: Inflammable gas; red gas label.

DIFLUOROMONOCHLOROMETHANE

Description: Gas
Formula: $CHClF_2$
Constants:
  Mol. Wt. 86.48
  B. P. -41°C
  Autoign. Temp. 1170°F
Toxicity Hazard Ratings:
  Acute Local: 0
  Acute Systemic: Inhalation 1
  Chronic Local: U
  Chronic Systemic: Inhalation 1
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or water spray (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of fluorides and chlorides; it can react with oxidizing materials.
Storage and Handling: Section 7

DIFLUOROPHOSPHORIC ACID, ANHYDROUS

Description: Mobile, strongly fuming, colorless liquid.
Formula: HPO_2F_2
Constants:
  Mol. Wt. 102
  M. P. -75°C
  B. P. 116°C
  Density 1.583 @25°/4°C
  Vap. D. 3.52
Toxicity: See Fluorides and Phosphoric Acid.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of fluorides and oxides of phosphorus; it will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Corrosive liquid; white label.
  Coast Guard Classification: Corrosive liquid; white label.

DIGERMANE

Synonym: Germanium hydride.
Description: Liquid or gas.
Formula: Ge_2H_6
Constants:
  Mol. Wt. 151.25
  B. P. 29°C
  M. P. -109°C
  Density Gas: 6.74 g/l @20°C
    Liquid: 1.98 @-109°C
Toxicity: Details unknown. See Hydrides and Germanium Compounds.
Fire Hazard: Dangerous. See Hydrides.
Explosion Hazard: Details unknown. See Hydrides.
Disaster Control: See Hydrides.
Storage and Handling: Section 7

DIGITALIN. See Digitalis.

DIGITALIS

Synonyms: Foxglove; purple foxglove; fairy gloves.
Description: Dried leaves of Digitalis Purpurea.

Composition: Digitoxin (0.2-0.4%), etc.
Toxicity Hazard Ratings:
Acute Local: Allergen 1
Acute Systemic: Ingestion 3
Chronic Local: Allergen 1
Chronic Systemic: Ingestion 2
Toxicology: An overdose can be fatal. 2.5 grams or 30 cc of the tincture is considered a toxic dose. It contains digitalin, digitalein, digitonin and digitoxin, the most toxic component. An overdose causes the eyes to become prominent, the pupils dilated and the sclera blue. Furthermore, it seems to affect the digestive system, causing nausea, vomiting, cardiac irregularities, and excessive doses cause heart failure. In addition to the nausea, great malaise and often headache are noted. If this material is taken for medical purposes and the above symptoms are noted, the dosage should be discontinued until medical advice can be obtained.
Treatment and Antidotes: Wash stomach with tannic acid or strong tea. Keep patient lying down. Administer stimulants such as caffeine or ammonia, atropine if pulse falls below 50 per minute, morphine for irritability. Call a physician.
Fire Hazard: Slight; when exposed to flame; can react with oxidizing materials (Section 6).
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DIGITOXIN. See Digitalis.

DIGLYCEROL TETRANITRATE
Description: Liquid.
Toxicity: Details unknown. See also TNT.
Fire Hazard: See Nitrates.
Explosion Hazard: Severe, when shocked or exposed to heat. See Explosives, High.
Disaster Control: Dangerous; shock will explode it; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; it can react vigorously with oxidizing and reducing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

DIGLYCOL CHLOROFORMATE
Description: Liquid
Formula: $ClCOOCH_2CH_2OCH_2CH_2OH$
Constants: Mol. Wt. 191.0
B. P. 125°C @5 mm
Flash P. 295°F (O. C.)
Vap. D. 5.83
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of chlorides; it will react with water or steam to produce toxic and corrosive fumes; it can react with oxidizing materials.
Storage and Handling: Section 7

DIGLYCOLCHLOROHYDRIN
Description: Colorless liquid.
Formula: $ClCH_2CH_2OCH_2CH_2OH$
Constants:
Mol. Wt. 124.57
B. P. 196.8°C
Flash P. 225°F (O. C.)
Density 1.1698
Vap. Press 0.17 mm @20°C
Toxic Hazard Ratings:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water; foam; carbon dioxide; dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of chlorides; it will react with water or steam to produce toxic and corrosive fumes; it can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIGLYCOL DIACETATE
Description: Liquid.
Formula: $CH_3COOC_2H_4OC_2H_4OCOCH_3$
Constants:
 Mol. Wt. 190.19
 M. P. 20°C
 B. P. 256.9°C
 Flash P. 225°F (O. C.)
 Density 1.1156 @20°/20°C
 Vap. D. 6.56
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water; foam; carbon dioxide; dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIGLYCOL DILEVULINATE. See Diethylene Glycol Dilevulinate.

DIGLYCOLIC ACID
Description: White; crystalline solid.
Formula: $O(CH_2COOH)_2$
Constants:
 Mol. Wt. 134.1
 M. P. 148°C
 B. P. Decomposes
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

DIGOXIN
Description: White; crystalline powder.
Formula: $C_{41}H_{64}O_{14}$
Constants:
 Mol. Wt. 780.9
 M. P. 265°C
Toxicity: Details unknown. See also Digitalis.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

DI-n-HEPTYLAMINE
Description: Liquid.
Formula: $(C_7H_{15})_2NH$
Constants:
 Mol. Wt. 213.4
 Vap. D. 7.35
Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Storage and Handling: Section 7

DIHEXYL ADIPATE
Synonym: Hexyl adipate.
Description: Liquid.
Formula: $(CH_2CH_2CO_2C_6H_{13})_2$
Constants:
 Mol. Wt. 314.5
 B. R. 168 - 170°C @4 mm
 Flash P. 325°F
 Density 0.926 @ 20°/20°C
 Vap. D. 10.85
Toxicity: Details unknown. See also Esters.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam; carbon dioxide; dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DI-n-HEXYLAMINE
Description: Liquid
Formula: $(C_6H_{13})_2NH$
Constants:
 Mol. Wt. 185.4
 B. P. 233 - 243°C
 Flash P. 220°F
 Density 0.78
 Vap. D. 6.38
Toxic Hazard Ratings:
 Acute Local: Irritant 1; Ingestion 1; Inhalation 1
 Acute Systemic: U
 Chronic Local: U
 Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water; foam; carbon dioxide; dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

DI-n-HEXYL MERCURY
Description: Liquid.
Formula: $Hg(C_6H_{13})_2$
Constants:
 Mol. Wt. 370.9
 B. P. 158°C @10 mm
 Density 1.5361
 Vap. D. 12.8
Toxicity: See Mercury Compounds, Organic.

Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of mercury; it can react with oxidizing materials.
Storage and Handling: Section 7

DIHEXYL PHTHALATE

Description: Liquid.
Formula: $C_6H_4(CO_2C_6H_{13})_2$
Constants:
Mol. Wt. 334.4
M. P. −58°C
B. P. 210°C @ 5 mm
Flash P. 350°F
Density: 0.995 @ 20°/20°C
Vap. D. 11.5
Toxicity: Details unknown. See Phthalic Acid.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam; carbon dioxide; dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIHEXYL SEBACATE

Description: Liquid.
Formula: $[(CH_2)_4CO_2C_6H_{13}]_2$
Constants:
Mol. Wt. 370.6
B. P. 184°C @1 mm
Flash P. 415°F
Density 0.911 @ 20°/20°C
Vap. D. 12.8
Toxicity: Details unknown. See also Esters.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam; carbon dioxide; dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIHEXYL SODIUM SULFOSUCCINATE

Description: Clear, viscous liquid.
Formula:
$C_6H_{13}CO_2CH_2\underline{CHCO_2C_6H_{13}}SO_3Na$
Constant:
Mol. Wt. 388
Toxic Hazard Ratings:
Acute Local: Irritant 1; Ingestion 1
Acute Systemic: U
Chronic Local: Irritant 1
Chronic Systemic: U
Fire Hazard: Moderate; when heated, it emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIHYDRAZINE SULFATE

Description: White, crystalline flakes.
Formula: $(N_2H_4)_2 \cdot H_2SO_4$
Constants:
Mol. Wt. 162.2
M. P. 104°C
B. P. 180°C Decomposes
Toxicity: Details unknown. See also Hydrazine.
Fire Hazard: Slight; when heated, it emits toxic fumes.
Storage and Handling: Section 7

9,10-DIHYDROANTHRACENE

Description: Crystals.
Formula: $C_6H_4CH_2C_6H_4CH_2$
Constants:
Mol. Wt. 180.2
Vap. D. 6.21
Toxicity: Details unknown; an insecticide.
Fire Hazard: Slight, when exposed to heat; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

2,3-DIHYDRO-2-FORMYL-1,4-PYRAN

Description: Liquid.
Formula: $\underline{OHCCH(CH_2)_2C}HCHO$
Constants:
Mol. Wt. 112.12
M. P. −90°C
B. P. 150.6°C
Density 1.0776 @ 20°/20°C
Vap. Press. 2.4 mm @ 20°C
Vap. D. 3.87
Toxicity: Details unknown.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

DIHYDROGEN POTASSIUM ARSENATE

Description: White solid.
Formula: KH_2AsO_4
Constant: Mol. Wt. 180
M. P. 288°C
Toxicity: Highly toxic; see Arsenic Compounds.

Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

1,2-DIHYDRO-4-METHOXY-1-METHYL-2-OXONICOTINONITRILE
Synonyms: Ricinine; ridicine.
Description: Crystals.
Formula: $C_8H_8N_2O_2$
Constants: Mol. Wt. 164.2
M. P. 201.5°C
Vap. D. 5.65
Toxicity: Highly toxic. See also Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

DIHYDROPENTABORANE. See Pentaborane, Unstable.

DIHYDROPYRAN
Description: Colorless, mobile liquid; ethereal odor.
Formula: C_5H_8O
Constants: Mol. Wt. 84.1
B. P. 85.6°C
Flash P. 4°F (C.C.)
Density 0.923 @20°/4°C
Vap. D. 2.90
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous! Keep away from heat and open flame!
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIHYDROTETRABORANE
Synonyms: Borobutane; boron hydride; tetraborondecahydride.
Description: Colorless gas; repulsive odor.
Formula: B_4H_{10}
Constants: Mol. Wt. 53.4
M. P. -120°C
B. P. 18°C
Density 0.59 (liquid @-70°C); 0.56 (liquid @-35°C)
Vap. Press 580 mm @6°C
Vap. D. 1.8
Toxic Hazard Rating:
Acute Local: Inhalation 3
Acute Systemic: Inhalation 3
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to flame or by spontaneous chemical reaction (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes; it will react with water or steam to produce heat and hydrogen; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

1,2-DIHYDRO-1,4,6-TRIMETHYL-2-OXONICOTINONITRILE
Toxicity: Probably highly toxic. See also Cyanides and Nicotine.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

1,2-DIHYDRO-2,2,4-TRIMETHYLQUINOLINE, POLYMERIZED
Description: Light tan powder.
Formula: $\underline{C_6H_4C(CH_3)CHC(CH_3)_2NH}$
Constants:
Mol. Wt. 173.3
M. P. 120°C
Density 1.08 @25°C
Toxicity: Details unknown. See also Quinoline.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

1,8-DIHYDROXYANTHRANOL
Synonyms: Anthralin; dithranol.
Description: Lemon yellow crystal.
Formula: $C_{14}H_{10}O_3$
Constants:
Mol. Wt. 226.2
M. P. 176 - 181°C
Vap. D. 7.79
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; when heated,

it emits smoke (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

1,4-DIHYDROXYANTHRAQUINONE
Description: Crystals.
Formula: $C_{14}H_8O_4$
Constants:
Mol. Wt. 240.2
M. P. 194°C
B. P. 450.0°C
Vap. Press. 1 mm @196.7°C
Vap. D. 8.3
Toxicity: Details unknown. A weak allergen.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

1,5-DIHYDROXYANTHRAQUINONE
Description: Green to yellow crystals.
Formula: $C_{14}H_8O_4$
Constants: Mol. Wt. 240.2
M. P. 280°C
B. P. Sublimes
Vap. D. 8.3
Toxicity: Details unknown. A weak allergen.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

1,8-DIHYDROXYANTHRAQUINONE
Description: Crystals.
Formula: $C_{14}H_8O_4$
Constants: Mol. Wt. 240.2
M. P. 193°C
Vap. D. 8.3
Toxicity: Details unknown. A weak allergen.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

ortho-**DIHYDROXYBENZENE.** See Catechol.

DIHYDROXY BENZYL DIMETHYL METHANE
Description: Flake material.
Formula:
$HOC_6H_4CH_2C(CH_3)_2CH_2C_6H_4OH$
Constants: Mol. Wt. 256.3
M. P. 152.5°C
B. P. 220°C @4 mm
Toxicity: Details unknown.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

DIHYDROXY DIAMINOMERCUROBENZENE
Formula: $OHNH_2C_6H_3HgC_6H_3OHNH_2$
Constants:
Mol. Wt. 416.9
Vap. D. 14.4
Toxicity: See Mercury Compounds, Organic.
Disaster Control: See Mercury Compounds, Organic.
Storage and Handling: Section 7

2,2'-DIHYDROXY-5,5'-DICHLORODIPHENYLMETHANE
Synonyms: 2,2'-Methylene bis (4-chlorophenol); G-4.
Description: Crystals.
Formula: $C_{13}H_{10}Cl_2O_2$
Constants:
Mol. Wt. 269.1
M. P. 177 - 178°C
Vap. D. 9.3
Vap. Press. 10^{-4} mm @100°C
Toxicity: Unknown; a fungicide.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of chlorides.
Storage and Handling: Section 7

N,N'-DIHYDROXYETHYLETHYLENE DIAMINE
Description: Liquid.
Formula:
$HOC_2H_4NHCH_2CH_2NHC_2H_4OH$
Constants:
Mol. Wt. 148.2
M. P. 98.1°C
B. P. 196°C @10 mm
Flash P. 355°F
Vap. D. 5.1
Toxicity: Details unknown. See also Amines.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIHYDROXYETHYL NITRAMINE DINITRATE
Toxicity: Details unknown.
Fire Hazard: See Nitrates.
Explosion Hazard: Severe, when shocked or exposed to heat.

Disaster Control: Dangerous; shock will explode it; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react vigorously with reducing materials.
Storage and Handling: Section 7

2,2'-DIHYDROXY-3,5,6,3',5',6'-HEXACHLORODIPHENYL METHANE. See Hexachlorophene.

DIHYDROXY OCTACHLORODIPHENYL

Formula: $C_{12}H_2O_2Cl_8$
Constants:
Mol. Wt. 461.8
Vap. D. 15.9
Toxic Hazard Rating:
Acute Local: Irritant 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 3 Inhalation 3; Skin Absorption 3
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of chlorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DIIODOACETYLENE

Synonym: Diiodoethyne.
Description: Colorless, rhombic, white crystals; unpleasant odor.
Formula: IC⋮CI
Constants:
Mol. Wt. 277.86
M. P. 78 - 82°C
B. P. 80 - 100°C Decomposes
Vap. D. 9.6
Toxicity: Details unknown. See also Halogenated Hydrocarbons, Aliphatic.
Explosion Hazard: Details unknown; many acetylene compounds are unstable.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of iodine.
Storage and Handling: Section 7

DIIODODIACETYLENE

Toxicity: Details Unknown. See also Halogenated Hydrocarbons, Aliphatic.
Explosion Hazard: Severe, when exposed to heat.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of iodine.
Storage and Handling: Section 7

DIIODODIETHYL SULFIDE

Description: Bright yellow prisms.
Formula: $(CH_2CH_2I)_2S$
Constants:
Mol. Wt. 215.08
M. P. 62°C
Vap. D. 7.41
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of iodides, oxides of sulfur.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DIIODOFORMOXIME

Description: Crystals.
Formula: CI_2NOH
Constants: Mol. Wt. 296.9
M. P. 69°C
Vap. D. 10.2
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of iodides and oxides of nitrogen.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIIRON PHOSPHIDE

Description: Blue-gray crystals or powder.
Formula: Fe_2P

Constants:
Mol. Wt. 142.68
M. P. 1290°C
Density 6.56
Toxicity: Probably high. See Phosphides.
Fire Hazard: Dangerous. See Phosphides.
Explosion Hazard: Moderate. See Phosphides.
Disaster Control: Dangerous. See Phosphides.
Storage and Handling: Section 7

DIISOAMYL MERCURY

Description: Liquid.
Formula: $Hg(C_5H_{11})_2$
Constants:
Mol. Wt. 342.9
B. P. 125°C @10 mm
Density 1.6397
Vap. D. 11.8
Toxicity: See Mercury Compounds, Organic.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: See Mercury Compounds, Organic.
Storage and Handling: Section 7

DIISOBUTYLAMINE

Description: Water-white liquid; amine odor.
Formula: $[(CH_3)_2CHCH_2]_2NH$
Constants: Mol. Wt. 129.24
M. P. −70°C
B. P. 139.5°C
Flash P. 85°F
Density 0.745 @20°/4°C
Vap. Press. 10 mm @30.6°C
Vap. D. 4.46
Toxicity: Details unknown. See Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

DIISOBUTYL CARBINOL

Synonym: Nonyl alcohol; 2,6-dimethyl heptanol-4.
Description: Colorless liquid.
Formula: $(CH_3)_2CHCH_2CHOHCH_2CH(CH_3)_2$
Constants:
Mol. Wt. 144.3
B. P. 173.3°C
Freezing P. −65°C
Flash P. 165°F
Density 0.8121 @20°/20°C
Vap. Press. 0.3 mm @20°C
Vap. D. 4.98
Toxicity: Details unknown. See also Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIISOBUTYLENE

Description: Liquid.
Formula: C_8H_{16}
Constants:
Mol. Wt. 112.2
M. P. −101°C
B. P. 102°C
Flash P. 20°F (C.C.)
Density 0.7227 @15.6°C
Vap. D. 3.97
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous! Keep away from heat and open flame!
Explosion Hazard: Unknown
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

DIISOBUTYL KETONE

Synonym: Isovalerone.
Description: Liquid.
Formula: $[(CH_3)_2CHCH_2]_2CO$
Constants:
Mol. Wt. 142.2
B. P. 166°C
Flash P. 120°F (C.C.)
Density 0.81
Vap. D. 4.9
Toxicity: Details unknown. See also Ketones.
MAC: ACGIH (tentative); 150 parts per million in air.

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  Coast Guard Classification: Combustible liquid.
  MCA warning label.

DIISOBUTYL MERCURY

Description: Colorless liquid.
Formula: $Hg(C_4H_9)_2$
Constants:
  Mol. Wt. 314.8
  M. P. Volatile @ 100°C
  B. P. 207°C
  Density 1.7678
  Vap. D. 10.8
Toxicity: See Mercury Compounds, Organic.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: See Mercury Compounds, Organic.
Storage and Handling: Section 7

DIISOBUTYL PHTHALATE

Description: Liquid.
Formula: $C_6H_4[COOCH_2CH(CH_3)_2]_2$
Constants:
  Mol. Wt. 278
  M. P. -64°C
  Flash P. 385°F
  Density 1.039 - 1.043
  Vap. D. 9.59
Toxicity: Details unknown. See Phthalic Acid.
Fire Hazard: Slight; when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

para, para'-DIISOCYANATODIPHENYL METHANE

Description: Crystals.
Formula: $OCNC_6H_4CH_2C_6H_4NCO$
Constants:
  Mol. Wt. 250.3
  B. P. 194 - 199°C @ 5 mm
  Freezing P. 37.2°C
  Density 1.19 @ 50°C
  Vap. D. 8.63
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: See Cyanides.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIISODECYL ADIPATE

Description: Clear, mobile, oily liquid.
Formula: $(CH_2CH_2CO_2C_{10}H_{21})_2$
Constants:
  Mol. Wt. 426
  B. P. 240°C @ 4 mm
  Flash P. 425°F (C.O.C.)
  Vap. D. 14.7
Toxicity: Details unknown. See also Esters.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIISODECYL PHTHALATE

Description: Clear, oily liquid; mild characteristic odor.
Formula: $(C_{10}H_{21}CO_2)_2C_6H_4$
Constants:
  Mol. Wt. 446.7
  Flash P. 450°F
  Density 0.966 @ 25°/25°C
  Vap. D. 15.4
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing agents.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIISOOCTYL ADIPATE

Description: Liquid.

Formula: $[(CH_2)_2CO_2C_8H_{17}]_2$
Constants:
Mol. Wt. 370.6
B. P. 207 - 213°C @4 mm
Flash P. 370°F
Density 0.930 @20°/20°C
Vap. D. 12.8
Toxicity: See Esters.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIISOOCTYL AZELATE

Description: Liquid.
Formula: $(CH_3)_2CH(CH_2)_5O_2C-(CH_2)_7CO_2(CH_2)_5CH(CH_3)_2$
Constants:
Mol. Wt. 412
B. P. 235°C @5 mm
M. P. < -59.5°C
Flash P. 415°F
Density 0.92 @20°C
Vap. D. 18.7
Toxicity: Details unknown. See also Esters.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIISOOCTYL PHENYL PHOSPHONATE

Description: Liquid.
Formula: $C_6H_5PO(OC_8H_{17})_2$
Constants:
Mol. Wt. 382
M. P. < 0°C
B. P. 180 - 190°C @1 mm
Density 0.973 @25°/25°C
Vap. D. 13.2
Toxicity: Details unknown. See Phosphates.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of phosphorus oxides.
Storage and Handling: Section 7

DIISOOCTYL PHTHALATE

Description: Liquid; mild odor.
Formula: $C_6H_4(CO_2C_8H_{17})_2$
Constants:
Mol. Wt. 390.5
B. P. 230 - 240°C @4 mm
Freezing P. -45°C
Flash P. 380°F
Density 0.986 @20°/20°C
Vap. D. 13.5
Toxicity: Details unknown. See Phthalic Acid.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIISOOCTYL SEBACATE

Description: Liquid.
Formula: $[(CH_2)_4CO_2C_8H_{17}]_2$
Constants:
Mol. Wt. 426.7
B. P. 248 - 255°C @4mm
Flash P. 470°F
Density 0.917 @20°/20°C
Vap. D. 14.7
Toxicity: Details unknown. See Esters.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIISOOCTYL STYRYLPHOSPHONATE

Description: Liquid.
Formula: $C_6H_5C_2H_2PO(OC_8H_{17})_2$
Constants:
Mol. Wt. 408
M. P. < 0°C
B. P. 185 - 190°C @1 mm
Density 0.977 @25°/25°C
Toxicity: Details unknown. See Phosphates.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes of phosphorus oxides.
Storage and Handling: Section 7

DIISOPROPANOLAMINE

Description: Liquid; amine-like odor.
Formula: $[CH_3CH(OH)CH_2]_2NH$
Constants:
Mol. Wt. 133.19
M. P. 42°C
B. P. 249°C
Flash P. 260°F (O.C.)

Density 0.9890 @45°/20°C
Vap. D. 4.59
Toxicity: See Amines.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide or dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIISOPROPYLAMINE

Description: Colorless liquid.
Formula: $[(CH_3)_2CH]_2NH$
Constants:
Mol. Wt. 101.19
B. P. 83 - 84°C
Flash P. 20°F (C.C.)
Density 0.722 @22.0°C
Vap. D. 3.5
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous! Keep away from heat and open flame!
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIISOPROPYL BENZENE

Description: Clear, colorless liquid.
Formula: $[(CH_3)_2CH]_2C_6H_4$
Constants:
Mol. Wt. 162.26
M. P. < -55°C
B. P. 205°C
Flash P. 170°F (O.C.)
Density 0.863-0.867 @25°/25°C
Autoign. Temp. 840°C
Vap. D. 5.6
Toxicity: Details unknown. See also Benzene.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIISOPROPYL CARBINOL

Synonym: 2,4-Dimethyl-3-pentanol.
Description: Colorless liquid.
Formula: $(C_3H_7)_2CHOH$
Constants:
Mol. Wt. 116.2
M. P. -70°C
B. P. 140°C
Flash P. 120°F
Density 0.8288 @20°/4°C
Vap. D. 4.0
Toxicity: See Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIISOPROPYL CYANAMIDE

Description: Colorless, mobile liquid; characteristic odor.
Formula: $(C_3H_7)_2NCN$
Constants:
Mol. Wt. 126.20
M. P. -27.3°C
B. P. 207°C
Flash P. 179.5°F
Density 0.8451 @30°C
Vap. Press. 9 mm @80°C
Vap. D. 4.34
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides; will react with water or steam to produce toxic and corrosive fumes; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3

Personal Hygiene: Section 3
Storage and Handling: Section 7

DIISOPROPYL DIXANTHOGEN

Description: Yellow to greenish pellets.
Formula: $(C_4H_7OS_2)_2$
Constants:
Mol. Wt. 270.5
M. P. 52°C
Density 1.28
Vap. D. 9.35
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur; will react with water or steam to produce toxic fumes; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIISOPROPYL FLUOROPHOSPHATE

Description: Oily liquid.
Formula: $C_8H_{14}FPO_3$
Constants:
Mol. Wt. 208.17
M. P. Above 50°C
B. P. 46°C @5 mm
Density 1.07 (approx.)
Vap. D. 5.24
Toxicity: Dangerous to eyes. See Fluorides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or moisture it emits highly toxic fumes of fluorides and oxides of phosphorus.
Storage and Handling: Section 7

DIISOPROPYL MERCURY

Description: Liquid.
Formula: $Hg(C_3H_7)_2$
Constants:
Mol. Wt. 286.8
B. P. 63°C @10 mm
Density 2.0024
Vap. D. 9.9
Toxicity: See Mercury Compounds, Organic.
Disaster Control: See Mercury Compounds, Organic.
Storage and Handling: Section 7

2,6-DIISOPROPYL PHENOL

Description: A colorless liquid or solid.
Formula:
$HC(CH_3)_2C_6H_3(OH)(CH_3)_2CH$
Constants:
Mol. Wt. 178.3
B. P. 242.4°C
Freezing P. 17.9°C
Flash P. 235°F (C.C.)
Density 0.955 @20°/4°C
Toxicity: Unknown
Fire Hazard: Slight; when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIISOPROPYL PHOSPHO FLUORIDATE

Description: Odorless, colorless liquid.
Constants:
B. P. 183°C
Freezing P. −82°C
Toxicity: Highly toxic; used by Germans in World War II as the basis of nerve gases. See Tabun and Sarin.

DIKERYL BENZENE-12

Description: Liquid.
Constant:
Flash P. 320°F
Toxicity: Details unknown. See also Benzene.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIKETENE

Synonym: Acetyl ketene.
Description: Colorless, non-hygroscopic liquid; pungent odor.
Formula: $C_4H_4O_2$
Constants: Mol. Wt. 84.07

M. P. −6.5°C
B. P. 127.4°C
Density 1.0897
Vap. D. 2.9

Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

DIMANGANESE ARSENIDE

Description: Solid.

Formula: Mn_2As

Constants:
Mol. Wt. 184.77
M. P. 1400°C

Toxicity: Highly toxic. See Arsenic Compounds.

Fire Hazard: Dangerous; when exposed to heat or by chemical reaction.

Explosion Hazard: See Arsine.

Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of arsenic; will react with water or acid to produce arsine; can react vigorously with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Storage and Handling: Section 7

2,3-DIMERCAPTO-1-PROPANOL

Synonyms: BAL; British Anti-Lewisite.

Description: Viscous, oily liquid; pungent odor.

Formula: $C_3H_8OS_2$

Constants:
Mol. Wt. 124.2
B. P. 140°C @40 mm
Density 1.2385 @25°/4°C
Vap. D. 4.3

Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: Ingestion 2
Chronic Local: U
Chronic Systemic: U

Toxicology: Applied locally to the skin it causes redness and swelling, but does not produce blisters or ulcers. It is intensely irritating to the eyes and mucous membranes. Systemic symptoms are caused by injection of the drug and usually occur within a few minutes, reaching their maximum in 15 to 30 minutes. At first there is a feeling of warmth with tingling sensations in the nose, mouth and skin. There may be nausea, vomiting, restlessness, weakness, rapid pulse and rise in blood pressure. In severe cases there may be tremors and convulsions.

Treatment is symptomatic. Epinephrine and antihistamines may be helpful. It may be necessary to give large doses of barbiturates of even anesthetics to control convulsions.

Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of sulfur compounds.

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

DIMERCURIC AMMONIUM OXIDE

Toxicity: See Mercury Compounds, Inorganic.

Explosion Hazard: Severe, when shocked or exposed to heat.

Disaster Control: Dangerous; shock or heat will explode it; when heated to decomposition, it emits highly toxic fumes of mercury.

Storage and Handling: Section 7

3,4-DIMETHOXYBENZYL ALCOHOL

Description: Colorless liquid.

Formula: $(CH_3O)_2C_6H_3CH_2OH$

Constants:
Mol. Wt. 168.2
M. P. 22°C
B. P. 174°C @15 mm
Density 1.17 @25°/25°C
Vap. D. 5.8

Toxicity: Details unknown. See also Alcohols.

Fire Hazard: Moderate; when heated, it emits acrid fumes; can react with oxidizing materials.

To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIMETHOXY DIPHENYL TRICHLOROETHANE

Description: Crystals (Methoxy Analog of DDT).
Formula: $Cl_3C_{14}H_9(OCH_3)_2$
Constants:
  Mol. Wt. 345.7
  Vap. D. 11.9
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIMETHOXY ETHYL PHTHALATE

Description: Light colored, clear liquid; mild aromatic odor.
Formula: $C_6H_4(COOC_2H_4OCH_3)_2$
Constants:
  Mol. Wt. 282
  M. P. -40°C (forms gel)
  B. P. 190 - 210°C @4 mm
  Flash P. 360°F
  Density 1.171 @20°/20°C
  Vap. Press. 0.3 mm @150°C
  Vap. D. 9.75
Toxicity: Details unknown. See also Esters.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

beta-3, 4-DIMETHOXYPHENYLETHYLAMINE

Description: Colorless to pale yellow liquid.
Formula: $(CH_3O)_2C_6H_3CH_2CH_2NH_2$
Constants:
  Mol. Wt. 181.2
  M. P. 15°C
  B. P. 156°C @10 mm
  Density 1.08 @28°/4°C
  Vap. D. 6.25
Toxicity: Details unknown. See also Amines.
Fire Hazard: Slight; when heated, it emits toxic fumes.
Storage and Handling: Section 7

1, 2-DIMETHOXYPROPANE

Description: Liquid.
Formula: $CH_3CHOCH_3CH_2OCH_3$
Constants:
  Mol. Wt. 104.15
  B. P. 95°C
  Density 0.8461
  Vap. D. 3.59
Toxicity: Details unknown.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7

DIMETHOXYTETRAETHYLENE GLYCOL. See Dimethoxytetraglycol.

DIMETHOXYTETRAGLYCOL

Synonyms: Tetraethylene glycol dimethyl ether; Dimethoxy tetraethylene glycol.
Description: Water-white, practically odorless liquid.
Formula: $(CH_3OC_2H_4OC_2H_4)_2O$
Constants:
  Mol. Wt. 222.28
  B. P. 275.3°C
  Freezing P. -29.7°C
  Flash P. 285°F (O. C.)
  Density 1.0132 @20°/20°C
  Vap. Press. 0.01 mm @20°C
  Vap. D. 7.7
Toxicity: See Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2, 5-DIMETHOXYTETRAHYDROFURAN

Description: Colorless liquid.
Formula: $(CH_3O)_2C_4H_6O$

Constants:
Mol. Wt. 132.16
B. P. 35°C @10 mm
Vap. D. 4.56
Toxicity: Details unknown
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

DIMETHYLACETAL

Synonym: Ethylidene dimethyl ether.
Description: Colorless liquid; strong aromatic odor.
Formula: $CH_3(OCH_3)_2CH$
Constants:
Mol. Wt. 90.12
B. P. 61.8°C
Flash P. Below 80°F
Density 0.848 @25°C
Vap. D. 3.1
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

N, N-DIMETHYL ACETAMIDE

Description: Liquid.
Formula: $CH_3CON(CH_3)_2$
Constants: Mol. Wt. 87.12
M. P. -20°C
B. P. 165°C
Density 0.9366 @25°/4°C
Vap. D. 3.01
Toxicity: Details unknown.
Fire Hazard: Slight; when heated, it emits toxic fumes.
Storage and Handling: Section 7

DIMETHYL ACETONYL CARBONYL

Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate; when heated, it emits acrid fumes; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIMETHYLAMINE, ANHYDROUS

Description: Colorless gas.
Formula: $(CH_3)_2NH$
Constants:
Mol. Wt. 45.08
B. P. 6.88°C
Flash P. 21°F (C.C.)
Freezing P. -92.19°C
Density 0.6804 @0°/4°C
Autoign. Temp. 756°F
Vap. D. 1.55
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 2.80% - 14.40% in air.
Disaster Control: Dangerous! Keep away from heat and open flame!
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable gas; red gas label.
Coast Guard Classification: Inflammable gas; red gas label.
MCA warning label.

DIMETHYLAMINE, AQUEOUS SOLUTION

Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

DIMETHYLAMINOCHLOROPROPANE

Description: Liquid.

Formula: $C_5H_{12}NCl$
Constants:
  Mol. Wt. 121.6
  Vap. D. 4.20
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIMETHYLAMINOETHANOL

Synonym: Dimethylethanolamine.
Description: Liquid.
Formula: $(CH_3)_2NCH_2CH_2OH$
Constants:
  Mol. Wt. 89.14
  B. P. 131°C
  Flash P. 88°F (O.C.)
  Density 0.8866 @20°/4°C
  Vap. D. 3.03
Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

1-DIMETHYLAMINO-2-PROPANOL

Description: Clear, amber-colored, volatile liquid.
Formula: $CH_3NHCH_2CHOHCH_3$
Constants:
  Mol. Wt. 89.2
  B. P. 122.5° - 126.2°C
  Flash P. 90°F
  Freezing P. <-20°C
  Density 0.850 @25°/25°C
  Vap. D. 3.52
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

DIMETHYLAMINOPROPIONITRILE

Description: Liquid.
Formula: $(CH_3)_2NCH_2CH_2CN$
Constants:
  Mol. Wt. 98.2
  M. P. -43°C
  B. P. 170°C
  Flash P. 147°F
  Density 0.8617
  Vap. D. 3.35
Toxicity: Highly toxic. See Cyanides.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

3-DIMETHYLAMINOPROPYLAMINE

Description: Colorless liquid.
Formula: $(CH_3)_2NCH_2CH_2CH_2NH_2$
Constants:
  Mol. Wt. 102.18
  M. P. <-70°C
  B. P. 123°C
  Flash P. 95°F (T.C.C.)
  Density 0.8100 @30°C
  Vap. Press. 10 mm @30°C
  Vap. D. 3.52
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; reacts vigorously with oxidizing materials, and emits toxic fumes when heated.
Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIMETHYL AMMONIUM DIMETHYLCARBAMATE

Description: Liquid or crystals.
Formula: $(CH_3)_2NCOONH_2(CH_3)_2$
Constants:
Mol. Wt. 134.17
M. P. ~38°C
B. P. 60.2°C
Density 1.026 @25°/4°C
Vap. D. 4.62
Toxicity: Unknown
Fire Hazard: Slight; on decomposition it emits toxic fumes.
Storage and Handling: Section 7

N, N-DIMETHYLANILINE

Synonym: Xylidine.
Description: Liquid.
Formula: $C_6H_5N(CH_3)_2$
Constants:
Mol. Wt. 121.18
M. P. 2.5°C
B. P. 193.1°C
Flash P. 145°F (C. C.)
Density 0.9557 @20°/4°C
Autoign. Temp. 700°F
Vap. Press. 1 mm @29.5°C
Vap. D. 4.17
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
MAC: ACGIH (accepted); 5 parts per million in air; 25 milligrams per cubic meter of air.
Toxicology: Its physiological action is similar to that of aniline, although it is believed to be more toxic. It acts as a depressant on the central nervous system. Oral or subcutaneous administration of 2 g/kg of body weight in guinea pigs has caused weakness, tremors, tonic and clonic convulsions, slowing of the respiration, and finally death due to respiratory paralysis. The hazard associated with this material is that untrained personnel will disregard small splashes of it upon the shoes, clothing, or body, and will use improperly ventilated equipment. Industrial accidents involving dimethyl aniline are dangerous in that they can release sudden massive quantities of the oil or its vapor from breaks in the pipes of a closed system. See also Aniline.
Fire Hazard: Moderate, when exposed to heat or flame.
Spontaneous Heating: No
Underwriters' Laboratory Classification: 20-25
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of Aniline; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

DIMETHYLARSINE

Synonym: Cacodyl hydride.
Description: Colorless liquid.
Formula: $(CH_3)_2AsH$
Constants: Mol. Wt. 106.0
B. P. 36°C
Density 1.213 @29°/4°C
Vap. D. 3.65
Toxicity: Highly toxic. See Asenic Compounds.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: Unknown
Disaster Control: See Asenic Compounds.
Storage and Handling: Section 7

DIMETHYLBENZENE. See Xylene.

DIMETHYLBENZYLCETYL AMMONIUM CHLORIDE

Formula:
$(CH_3)_2(C_6H_5CH_2)C_{16}H_{33}NCl$
Constants:
Mol. Wt. 436.1
Vap. D. 15
Toxic Hazard Rating:
Acute Local: Irritant 2;

Ingestion 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits smoke (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIMETHYL BERYLLIUM

Description: White needles.
Formula: $Be(CH_3)_2$
Constants:
Mol. Wt. 39.09
B. P. Sublimes @200°C
Toxicity: Highly toxic. See Beryllium Compounds.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of beryllium oxide; can react with oxidizing materials.
Storage and Handling: Section 7

2, 2-DIMETHYLBUTANE

Synonym: Neohexane.
Description: Liquid.
Formula: $(CH_3)_3CCH_2CH_3$
Constants:
Mol. Wt. 86.2
B. P. 49.7°C
Flash P. <20°F
Freezing P. −101.9°C
Density 0.649
Autoign. Temp. 797°F
Vap. Press. 400 mm @31.0°C
Vap. D. 3.00
Toxicity: Details unknown.
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; keep away from heat and open flame!
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

2, 3-DIMETHYLBUTANE

Synonym: Diisopropyl.
Description: Liquid.
Formula: $(CH_3)_2CHCH(CH_3)_2$
Constants:
Mol. Wt. 86.17
M. P. −135.1°C
B. P. 58.0°C
Flash P. <20°F
Density 0.662 @20°>4°C
Autoign. Temp. 788°F
Vap. Press. 400 mm @39.0°C
Vap. D. 3.0
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous! Keep away from heat or open flame!
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

1, 3-DIMETHYL BUTYLAMINE

Description: A liquid.
Formula: $CH_3CH(NH_2)CH_2CH(CH_3)_2$
Constants:
Mol. Wt. 101.2
B. P. 106° - 109°C
Flash P. 55°F
Density 0.750 at 20°/20°C
Toxicity: See Amines.
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

DIMETHYL CARBAMYL CHLORIDE

Synonym: N, N-Dimethyl carbamyl chloride.
Description: Liquid.
Formula: $(CH_3)_2NCOCl$
Constants:
Mol. Wt. 107.5
M. P. −33°C
B. P. 165°−167°C
Density 1.678 @20°/4°C
Vap. D. 3.73
Toxicity: Lachrymator; strong local irritant action.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; it will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

DIMETHYL CARBATE

Synonym: Cis-bicyclo (2, 2, 1)-5-heptene-2, 3-dicarboxylic acid dimethyl ester.
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1; Inhalation 1
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIMETHYLCARBINOL. See sec-Propyl Alcohol.

alpha, alpha-DIMETHYL-alpha'-CARBOBUTOXYDIHYDRO-gamma-PYRONE

Synonym: n-Butyl mesityl oxide oxalate.
Description: Amber liquid.
Formula:
  $OC(CH_3)CH_2COCHCCOOC_4H_9$
Constants: Mol. Wt. 226. 3
  B. P. 113°C
  Flash P. 315°F
  Density 1. 08 @20°/20°C
  Vap. D. 7. 8
Toxicity: Details unknown. Insect repellent.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DI(METHYL "CELLOSOLVE") MALEATE

Description: Liquid.
Formula:
  $CH_3OCH_2CH_2OCOCH{:}CHCOOCH_2\text{-}CH_2OCH_3$
Constants:
  Mol. Wt. 232. 23
  M. P. −50°C
  B. P. 152°C @5 mm
  Density 1. 1413 @20°/20°C
  Vap. D. 8. 01
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight; when heated, it emits smoke; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

DIMETHYLCHLORACETAL

Description: Colorless liquid.
Formula: $ClCH_2CH(OCH_3)_2$
Constants:
  Mol. Wt. 124. 6
  B. P. 126°−132°C
  Flash P. 110°F
  Density 1. 082-1. 092 @25°/4°C
  Autoign. Temp. 450°F
  Vap. D. 4. 3
Toxicity: Details unknown.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react with oxidizing materials.
Storage and Handling: Section 7

DIMETHYL CHLOROARSINE

Synonyms: Cacodyl chloride; chlorodimethylarsine.
Description: Colorless liquid.
Formula: $(CH_3)_2AsCl$
Constants: Mol. Wt. 140. 44
  M. P. Below −45°C
  B. P. 106. 5°C
  Density Above 1
  Vap. D. 4. 84
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

DIMETHYL beta-CHLOROETHYLAMINE

Description: Liquid.
Formula: $(CH_3)_2NC_2H_4Cl$
Constants:
  Mol. Wt. 107. 6
  Vap. D. 3. 72
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIMETHYL CYANAMIDE

Description: Colorless, mobile liquid.
Formula: $(CH_3)_2NCN$
Constants: Mol. Wt. 74.09
M. P. -41.0°C
B. P. 160°C
Flash P. 160°F (T.C.C.)
Density 0.8768 @ 30°C
Vap. Press. 40 mm @ 80°C
Vap. D. 2.55
Toxicity: Highly toxic. See Cyanides.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides; it will react with water or steam to produce toxic and flammable vapors; can react with oxidizing materials.
Storage and Handling: Section 7

p-DIMETHYLCYCLOHEXANE

Synonym: Hexahydroxyl.
Description: Liquid.
Formula: $(CH_3)_2C_6H_{10}$
Constants:
Mol. Wt. 112.21
M. P. -86°C
B. P. 119.5°C
Flash P. 52°F (C.C.)
Density 0.77
Vap. Press. 10 mm @ 10.3°C
Vap. D. 3.86
Toxicity: See Cycloparaffins.
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous! Keep away from heat and open flame!
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

DIMETHYLDICHLOROSILANE

Description: Liquid.
Formula: $(CH_3)_2SiCl_2$
Constants: Mol. Wt. 129.1
M. P. -86°C
B. P. 70°C
Vap. D. 4.44
Toxicity: Probably high. See Chlorosilanes.
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 3.4 - > 9.5%
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; it will react with water or steam to produce heat and toxic and corrosive fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Inflammable liquid; red label.

DIMETHYLDIDODECYLAMMONIUM CHLORIDE

Description: Solid.
Formula: $(CH_3)_2(C_{12}H_{25})_2NCl$
Constants: Mol. Wt. 418.2
Vap. D. 14.4
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated, it emits smoke and toxic fumes of chlorine.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIMETHYL DINITRO OXAMIDE

Description: Crystals.
Formula: $(CH_3)_2NCOCON(NO_2)_2$
Constant: Mol. Wt. 206.1

Toxicity: Details unknown.
Fire Hazard: See Nitrates.
Explosion Hazard: Severe, when shocked or exposed to heat. See also Explosives, High.
Disaster Control: Dangerous; shock will explode it; when heated, it emits highly toxic fumes; can react vigorously with reducing materials.
Storage and Handling: Section 7

DIMETHYLDIOXANE
Description: Water-white liquid.
Formula: $OCH(CH_3)CH_2OCH_2CH(CH_3)$
Constants:
- Mol. Wt. 116.16
- B. P. 117.5°C
- Flash P. 75°F
- Density 0.9268
- Vap. Press. 15.4 mm@20°C

Toxic Hazard Rating:
- Acute Local: Irritant 2; Ingestion 2; Inhalation 2
- Acute Systemic: Ingestion 2; Inhalation 2
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

3, 6-DIMETHYL-2, 5-p-DIOXANE-DIONE
Synonym: Lactide.
Description: Pale yellow, crystalline solid.
Formula: $C_6H_8O_4$
Constants:
- Mol. Wt. 144.1
- M. R. 96 - 104°C

Toxicity: Unknown
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

DIMETHYLENEIMINE
Synonym: Ethylenimine.
Description: Oily liquid.
Formula: $\underline{NHCH_2CH_2}$
Constants:
- Mol. Wt. 43.07
- B. P. 55° - 56°C
- Density 0.832 @20°/4°C
- Vap. D. 1.49

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: U
- Chronic Local: Inhalation 3
- Chronic Systemic: Inhalation 2

Fire Hazard: Slight; when heated, it emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIMETHYL ETHANOLAMINE
Synonym: Dimethylamino ethanol.
Description: Clear liquid.
Formula: $(CH_3)_2N(CH_2)_2OH$
Constants:
- Mol. Wt. 89.14
- B. P. 133°C
- Flash P. 88°F (O. C.)
- Density 0.887
- Vap. Press. 10 mm @20°C

Toxicity: Details unknown. See Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

DIMETHYLETHANOLOCTADECYL AMMONIUM CHLORIDE
Description: Solid.
Formula: $(CH_3)_2(C_2H_5O)(C_{18}H_{37})NCl$
Constants:
- Mol. Wt. 378.1
- Vap. D. 13.0

Toxic Hazard Rating:
- Acute Local: Irritant 2; Ingestion 2; Inhalation 2
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Slight; when heated, it emits toxic fumes.
Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIMETHYL ETHER

Synonyms: Methyl ether; methyl oxide.
Description: Colorless liquid.
Formula: CH_3OCH_3
Constants:
- Mol. Wt. 46.07
- M. P. -138.5°C
- B. P. -23.7°C
- Flash P. -42°F (C.C.)
- Density 0.661
- Autoign. Temp. 662°F
- Vap. D. 1.59

Toxicity: Details unknown. See also Ethers.
Fire Hazard: Highly dangerous when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Dangerous, when exposed to flame, sparks, etc.
Explosive Range: 3.45 - 26.7%
Disaster Control: Highly dangerous! Keep in closed container away from heat and open flame!
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
- I. C. C. Classification: Flammable gas; red gas label.
- Coast Guard Classification: Inflammable gas; red gas label.

DIMETHYL ETHYL CARBINOL.

See tert-Amyl Alcohol.

DIMETHYLETHYLENE BIS-GLYCOLATE

Description: Liquid.
Formula: $(CH_2OCH_2CO_2CH_3)_2$
Constants:
- Mol. Wt. 206.2
- B. P. 145° - 146°C @4 mm
- Flash P. 290°F (O.C.)
- Density 1.1994 @25°/25°C
- Vap. D. 7.11

Toxicity: Details unknown. See Esters.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2, 3-DIMETHYL-3-ETHYLPENTANE

Description: Liquid.
Formula: C_9H_{20}
Constants:
- Mol. Wt. 128.25
- B. P. 142°C
- Flash P. 47°F
- Density 0.754 @20°C
- Vap. D. 4.43

Toxicity: Details unknown.
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous! Keep away from heat and open flame!
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

DIMETHYL FLUOROPHOSPHATE

Description: Liquid.
Formula: $(CH_3O)_2POF$
Constants:
- Mol. Wt. 128.1
- M. P. Low
- B. P. 149°C
- Density 1.28
- Vap. D. 4.42

Toxicity: Details unknown. See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

DIMETHYL FORMAMIDE

Description: Colorless, mobile liquid.
Formula: $(CH_3)_2NCHO$
Constants:
- Mol. Wt. 73.1
- B. P. 152.8°C
- Flash P. 153°F (T.O.C.)
- Freezing P. -61°C
- Density 0.9445 @25°/4°C
- Autoign. Temp. 833°F
- Vap. Press. 3.7 mm @25°C
- Vap. D. 2.51

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 2.2 – 15.2% @ 100°C
Caution: Avoid contact with halogenated hydrocarbons and inorganic nitrates.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

2, 5-DIMETHYL FURANE
Description: Colorless liquid.
Formula: $C_4H_2O(CH_3)_2$
Constants:
 Mol. Wt. 96.12
 B. P. 94°C
 Flash P. 45°F
 Density 0.9026 @17.7°/4°C
 Vap. D. 3.31
Toxic Hazard Rating:
 Acute Local: Irritant 1; Ingestion 1; Inhalation 1
 Acute Systemic: U
 Chronic Local: U
 Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous! Keep away from heat and open flame!
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIMETHYLGLYCOL PHTHALATE
Synonym: Dimethyl "Cellosolve" phthalate.
Description: Liquid.
Formula: $C_6H_4[COO(CH_2)_2OCH_3]_2$
Constants: Mol. Wt. 282.3
 B. P. 230°C
 Flash P. 369°F (C.C.)
 Density 1.17
 Vap. D. 9.72
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2, 5-DIMETHYLHEPTANE
Description: Liquid.
Formula: C_9H_{20}
Constants:
 Mol. Wt. 128.25
 B. P. 136°C
 Flash P. 73.5°F
 Density 0.715 @20°C
 Vap. D. 4.42
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

3, 5-DIMETHYLHEPTANE
Description: Liquid.
Formula: C_9H_{20}
Constants:
 Mol. Wt. 128.25
 B. P. 136°C
 Flash P. 73.5°F
 Density 0.723 @20°C
 Vap. Press. 9.5 mm @25°C
 Vap. D. 4.42
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

4, 4-DIMETHYLHEPTANE
Description: Liquid.
Formula: C_9H_{20}

Constants:
Mol. Wt. 128.25
B. P. 135.2°C
Flash P. 73.5°F
Density 0.72 @25°/4°C
Vap. Press. 10.4 mm @25°C
Vap. D. 4.42
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

2, 6-DIMETHYLHEPTENE-3 (cis and trans ISOMERS)
Description: A clear liquid.
Formula: C_9H_{18}
Constants: Mol. Wt. 126.23
B. P. 128.5 - 129°C
Flash P. 70°F (T. O. C.)
Density 0.722 @15.5°/15.5°C
Vap. Press. 28.4 mm @38°C
Vap. D. 4.38
Toxicity: Details unknown.
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use moderate rate).
Storage and Handling: Section 7

2, 5-DIMETHYLHEXADIENE-2, 4
Description: Liquid.
Formula: $(CH_3)_2CCHCHC(CH_3)_2$
Constants: Mol. Wt. 110.12
M. P. -91.3°C
B. P. 102.5°C
Density 0.762 @20°/20°C
Vap. D. 3.8
Toxicity: Details unknown.
Fire Hazard: Moderate; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2, 3-DIMETHYLHEXANE
Description: A clear liquid.
Formula: C_8H_{22}
Constants:
Mol. Wt. 118.26
B. P. 116°C
Flash P. 113°F
Density 0.716 @15.5°/15.5°C
Vap. D. 4.1
Toxicity: Details unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7

2, 4-DIMETHYLHEXANE
Description: A liquid.
Formula: C_8H_{18}
Constants:
Mol. Wt. 114.23
B. P. 109°C
Flash P. 50°F
Density 0.705 @15.5°/15.5°C
Vap. D. 4.1
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use moderate rate).
Storage and Handling: Section 7

2, 5-DIMETHYLHEXANE-2, 5-DIOL
Description: Crystals.
Formula:
$(CH_3)_2(OH)C(CH_2)_2C(OH)(CH_3)_2$
Constants:
Mol. Wt. 146.14
M. P. 88 - 89°C
Vap. D. 5.03
Toxicity: Details unknown
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

DIMETHYLHEXYNEDIOL
Description: White crystals.
Formula: $C_8H_{14}O_2$
Constants:
Mol. Wt. 142.2
M. P. 94 - 95°C

B. P. 205 - 206°C
Vap. D. 4.9
Toxicity: Details unknown.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

DIMETHYLHEXYNOL

Synonym: 3,5-Dimethyl-1-hexyn-3-ol.
Description: Colorless liquid; camphor-like odor.
Formula:
$CH_3CH(CH_3)CH_2C(CH_3)(OH)C{\equiv}CH$
Constants:
Mol. Wt. 126.5
B. P. 150 - 151°C
Freezing P. −68°C
Flash P. 134°F (T.O.C.)
Density 0.8545 @20°/20°C
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIMETHYL HYDANTOIN

Synonym: alpha-Ureido-isobutyric acid lactam.
Description: White, crystalline solid.
Formula: $C_5H_8O_2N_2$
Constants:
Mol. Wt. 128.13
M. P. 178°C
Vap. D. 4.4
Toxicity: Details unknown. Hydantoins are related to barbiturates and have a depressant action on the central nervous system. See also Barbiturates.
Fire Hazard: Slight; when heated; it emits acrid fumes.
Storage and Handling: Section 7

DIMETHYL HYDANTOIN-FORMALDEHYDE RESIN

Description: Colorless to lightly yellow, brittle lumps; odorless or faint carmel-like odor.
Constants:
Mol. Wt. 240 - 300 (average)
M. P. 60°C (minimum)
Density 1.30
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Toxicology: This resin contains a small percentage of formaldehyde (about 0.3% maximum) which may cause dermatitis in individuals sensitive to formaldehyde. When crushed or ground it gives a fine dust which may pass through ordinary respirators irritating mucous membranes and leading to sore throat, coughing and occasionally vomiting.

In case of contact with the body, individuals are advised to flush skin or eyes with water. In grinding or crushing operations, adequate ventilation should be provided.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

asym-DIMETHYLHYDRAZINE

Description: Colorless liquid, ammonia-like odor.
Formula: $(CH_3)_2NNH_2$
Constants:
Mol. Wt. 60.1
B. P. 63.3°C
Freezing P. −58°C
Flash P. 34°F (T.C.C.)
Density 0.782 @25°/4°C
Vap. Press. 157 mm @25°C
Vap. D. 1.94
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Highly dangerous; when heated to decomposition, it emits highly toxic fumes of nitrogen compounds; can react

vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

N, N-DIMETHYL HYDROXYACETAMIDE
Description: Crystals.
Formula: $HOCH_2CON(CH_3)_2$
Constants:
Mol. Wt. 103.12
M. P. 45°C
B. P. 213°C
Density 1.076 @50°/4°C
Toxicity: Details unknown
Fire Hazard: Slight; when heated, it emits toxic fumes.
Storage and Handling: Section 7

DIMETHYLISOPROPANOLAMINE
Description: Liquid.
Formula: $C_3H_7ON(CH_3)_2$
Constants:
Mol. Wt. 103.2
M. P. −85°C
B. P. 125.8°C
Flash P. 105°F
Density 0.86
Vap. Press. 9.0 mm @20°C
Vap. D. 3.55
Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

DIMETHYL MALEATE
Description: Liquid.
Formula: $(=CHCOOCH_3)_2$
Constants:
Mol. Wt. 144.12
M. P. −17.5°C
B. P. 205.0°C
Flash P. 235°F (O. C.)
Density 1.153
Vap. Press. 1 mm @45.7°C
Vap. D. 4.97
Toxicity: See Esters.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

O, O, -DIMETHYL-O, p-NITROPHENYL THIOPHOSPHATE
Synonym: Dimethyl analog of parathion.
Description: Crystals.
Formula: $(CH_3O)_2SPOC_6H_4NO_2$
Constants:
Mol. Wt. 263.2
Vap. D. 9.1
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DIMETHYL OCTYNEDIOL
Synonym: 3, 6-Dimethyl-4-octyne-3, 6-diol.
Description: White crystals.
Formula: $C_{10}H_{18}O_2$
Constants:
Mol. Wt. 170.3
M. P. 55 - 56°C
B. P. 135°C @20 mm
Vap. D. 5.9
Toxicity: Details unknown; probably toxic.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

2, 3-DIMETHYLPENTANE
Synonym: Diethyldimethylmethane.
Description: Liquid.
Formula: C_7H_{16}
Constants:
Mol. Wt. 100.20
M. P. −135°C
B. P. 89.8°C
Density 0.69 @15.5°/15.5°C
Autoign. Temp. 639°F

Flash P. < 20°F
Vap. Press. 40 mm @13.9°C
Vap. D. 3.45
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

2, 4-DIMETHYLPENTANE
Description: A clear liquid.
Formula: C_7H_{16}
Constants: Mol. Wt. 100.2
M. P. −123.4°C
B. P. 80.3°C
Freezing P. −119.4°C
Flash P. < 20°F
Density 0.6728 @20°/4°C
Vap. Press. 8.2 mm @21°C
Vap. D. 3.48
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous. Keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

DIMETHYL p-PHENYLENEDIAMINE
Synonym: p-Aminodimethyl aniline.
Description: Crystalline mass.
Formula: $C_6H_4NH_2N(CH_3)_2$
Constants: Mol. Wt. 136.20
M. P. 53°C
B. P. 150°C @17 mm
Density 1.036 @20/4°C
Vap. D. 4.69
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3
Fire Hazard: Slight; when heated, it emits toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DIMETHYL PHOSPHINE
Description: Colorless liquid.
Formula: $(CH_3)_2PH$
Constants:
Mol. Wt. 62.1
B. P. 25°C
Density < 1
Vap. D. 2.14
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3
Fire Hazard: Dangerous, when exposed to heat or flame; spontaneously flammable in air.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ortho-DIMETHYL PHTHALATE
Description: Colorless, odorless liquid.
Formula: $C_6H_4(COOCH_3)_2$
Constants:
Mol. Wt. 194.18
B. P. 283.7°C
Flash P. 295°F (C.C.)
Density 1.189 @25°/25°C
Autoign. Temp. 1032°F
Vap. D. 6.69
Vap. Press. 1 mm @100.3°C
Toxic Hazard Rating:
Acute Local: Allergen 1; Ingestion 2
Acute Systemic: U

Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

cis-2, 5-DIMETHYLPIPERAZINE

Description: A liquid; typical amine odor.
Formula: $C_6H_{14}N_2$
Constants:
Mol. Wt. 144.1
M. P. 17.5°C
B. P. 164.5°C @746 mm
Flash P. 154.5°F (C.O.C.)
Density 0.9195 @25°/25°C
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

trans-2, 5-DIMETHYLPIPERAZINE

Description: Crystals; typical amine odor.
Formula:
$H\underline{NCH_2CH(CH_3)NHCH_2C}H(CH_3)$
Constants:
Mol. Wt. 114.19
M. P. 117.5°C
B. P. 161.9°C @746 mm
Flash P. 210°F (O.C.)
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2, 2-DIMETHYLPROPANE

Synonym: Neopentane.
Description: Liquid.
Formula: $(CH_3)_4C$
Constants:
Mol. Wt. 72.2
B. P. 9.5°C
Freezing P. −18.2°C
Flash P. < 20°F
Density 0.590 @20°/4°C
Autoign. Temp. 842°F
Vap. Press. 1100 mm @21°C
Vap. D. 2.48
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

2, 2-DIMETHYL-1, 3-PROPANEDIOL.

See Neopentyl Glycol.

2, 5-DIMETHYLPYRAZINE

Description: A liquid; pyridine odor.
Formula: $C_6H_8N_2$
Constants:
Mol. Wt. 108
M. P. 15°C
B. P. 154°C @742 mm
Flash P. 147.3°F (C.O.C.)
Density 0.9873 @25°/25°C
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIMETHYL SEBACATE

Synonyms: Methyl sebacate.
Description: Liquid.
Formula: $[(CH_2)_4CO_2CH_3]_2$
Constants:
Mol. Wt. 230.3
M. P. 38°C
B. P. 293.5°C
Flash P. 293°F
Density 0.986 @30°/25°C
Vap. Press. 1 mm @104.0°C
Vap. D. 7.95
Toxicity: See Esters and Methyl Alcohol.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIMETHYL SELENIDE

Synonym: Methyl selenide.
Description: Liquid.
Formula: $(CH_3)_2Se$
Constants: Mol. Wt. 109.0
B. P. 58°C
Density 1.4077 @14.6°/4°C
Vap. D. 3.75
Toxicity: See Selenium and its Compounds.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of selenium; will react with water, steam, acid or acid fumes to produce toxic fumes; can react vigorously with oxidizing materials.
First Aid: Section 1
Storage and Handling: Section 7

DIMETHYL SULFATE

Synonym: Methyl sulfate.
Description: Colorless liquid.
Formula: $(CH_3)_2SO_4$
Constants: Mol. Wt. 126.13
M. P. −31.8°C
B. P. 188°C
Flash P. 182°F (C.C.)
Density 1.3322 @20°/4°C
Vap. D. 4.35
Toxic Hazard Rating:
Acute Local: Irritant 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: Irritant 3; Inhalation 3
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
MAC: ACGIH (accepted); 1 part per million in air; 5 milligrams per cubic meter of air.
Toxicology: Contact of the skin and mucous membranes with the liquid or vapor, even for short periods, results in intense irritation of these tissues several hours later. There is no odor or initial irritation to give warning of exposure. On brief, mild exposures, conjunctivitis, catarrhal inflammation of the mucous membranes of the nose, throat, larynx and trachea and possibly some reddening of the skin develop after the latent period. With longer, heavier exposures, the cornea shows clouding, the irritative changes of the nasopharynx are more marked and after 6 to 8 hours pulmonary edema may develop. Death may occur in 3 or 4 days. The liver and kidneys are frequently damaged. Spilling of the liquid on the skin can cause ulceration and local necrosis. The fatal concentration for cats and monkeys is in the range of 25 to 200 ppm of the vapor in air.

After a latent period of several hours, there is severe lacrimation, conjunctivitis, photophobia, coughing and hoarseness, followed, in the case of more severe exposures, by chest pain, dyspnea, cyanosis and possibly death. In patients surviving severe exposures, there may be serious injury to the liver and kidneys, with suppression of urine, jaundice, albuminuria and hematuria appearing. Death, resulting from the kidney or liver damage, may be delayed for several weeks.

Fire Hazard: Moderate, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.
MCA warning label

DIMETHYL SULFIDE

Synonym: Methyl sulfide.
Description: Colorless liquid.
Formula: $(CH_3)_2S$
Constants:
Mol. Wt. 62.13
M. P. −83.2°C

B. P. 36.0°C
Density 0.8458 @21°/4°C
Autoign. Temp. 403°F
Vap. D. 2.14
Toxicity: High. See Sulfides.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

DIMETHYLSULFOLANE

Description: Solid.
Formula: $C_6H_{12}SO_2$
Constants:
Mol. Wt. 148.22
B. P. 280°C
Flash P. 290°F (O.C.)
Density 1.1362 @20°/4°C
Vap. Press. 0.006 mm @20°C
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react with oxidizing materials.
Storage and Handling: Section 7

DIMETHYL SULFOXIDE

Description: Clear, water-white, hygroscopic liquid.
Formula: $(CH_3)_2SO$
Constants:
Mol. Wt. 78.13
M. P. 6°C
B. P. decomp. @100°C
Flash P. 203°F (O.C.)
Density 1.100 @20°C
Vap. Press. 0.37 mm @20°C
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

DIMETHYL TETRAHYDROPHTHALATE

Synonym: Dimethyl-1-cyclohexene-1,2-dicarboxylic acid.
Description: Crystals.
Formula: $C_6H_8(COOCH_3)_2$
Constants:
Mol. Wt. 198.2
Vap. D. 6.83
Toxicity: Probably slight. See Phthalic Acid.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

2,6-DIMETHYL TETRAHYDRO-1,4-PYRONE

Formula: $C_7H_{14}O_2$
Constants:
Mol. Wt. 130.2
Vap. D. 4.48
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes.
Ventilation Control: Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

3,5-DIMETHYLTETRAHYDRO-1,3,5,2-H-THIODIAZINE-2-THIONE

Description: White crystalline powder.
Formula: $C_5H_{10}N_2S_2$
Constants:
Mol. Wt. 162.2
M. P. 105 - 107°C
Vap. D. 5.59
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur and nitrogen.

Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIMETHYLTRITHIOCARBONATE
Description: Crystals.
Formula: $CS_3(CH_3)_2$
Constants: Mol. Wt. 139.26
Vap. D. 4.8
Toxic Hazard Ratings:
Acute Local: Irritant 3; Inhalation 3
Acute Systemic: Inhalation 3
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur; it can react with oxidizing materials.
Ventilation Control: (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

"DIMITE". See Di(p-Chlorophenyl) Methyl Carbinol.

DIMORPHOLINETHIURAM DISULFIDE
Toxicity: Details unknown; a fungicide.
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes.
Storage and Handling: Section 7

DI-β-NAPHTHYL-p- PHENYLENE DIAMINE
Description: Solid.
Formula: $(C_{10}H_7)_2NC_6H_4NH_2$
Constants:
Mol. Wt. 360.42
Vap. D. 12.4
Toxicity: Details unknown; probably toxic. See p-Phenylene Diamine.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

DINICKEL PHOSPHIDE
Description: Gray Crystals
Formula: Ni_2P
Constants:
Mol. Wt. 148.36
M. P. 1112°C
Density: 6.31 @15°C
Toxicity: Highly toxic. See Phosphine.
Fire Hazard: See Phosphides.
Explosion Hazard: See Phosphides.
Disaster Control: See Phosphides.
Storage and Handling: Section 7

"DINITRO". See 4,6-Dinitro-o-Cresol.

2,4-DINITROANILINE
Synonym: 2,4-Dinitrophenylamine.
Description: Crystals.
Formula: $(NO_2)_2C_6H_3NH_2$
Constants:
Mol. Wt. 183.13
M. P. 180°C
B. P. 56.7°C
Flash P. 435°F (C. C.)
Density 1.615
Vap. D. 6.31
Toxic Hazard Ratings:
Acute Local: Irritant 2
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water; carbon dioxide; dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; it can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

2,4-DINITRO ANISOLE
Synonym: 2,4-Dinitrophenylmethyl ether.
Description: Colorless to yellow crystals.
Formula: $CH_3OC_6H_3(NO_2)_2$
Constants:
Mol. Wt. 198.1
M. P. 89°C
B. P. Sublimes
Density 1.341 @20°/4°C
Vap. D. 6.83

Toxicity: Details unknown. See Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

1,2-DINITROBENZENE

Synonyms: o-Dinitrobenzol.
Description: Colorless or yellowish needles or plates.
Formula: $C_6H_4(NO_2)_2$
Constants:
Mol. Wt. 168.11
M. P. 118°C
B. P. 302.8°C @770 mm
Flash P. 302°F (C.C.)
Density 1.571 @0°/4°C
Vap. D. 5.79
Toxic Hazard Ratings:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water; carbon dioxide; dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Severe, when shocked or exposed to heat or flame. This compound is a high explosive used in bursting charges and to fill artillery shells. It is a useful industrial explosive when mixed with more powerful explosives or with oxygen carriers, such as inorganic nitrates or chlorates or with ammonium nitrate.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen and explodes, it can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11. Coast Guard Classification: Poison B (liquid, solid); poison label required.

2,4-DINITROBENZENE SULFENYL CHLORIDE

Description: Bright yellow, crystalline solid.
Formula: $C_6H_3SCl(NO_2)_2$
Constants:
Mol. Wt. 234
M. P. 95° - 96°C
Vap. D. 8.08
Toxicity: Details unknown. See also Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: See Nitrates.
Explosion Hazard: Slight, when shocked.
Disaster Control: Dangerous; shock will explode it; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur and nitrogen; it will react with water or steam to produce toxic and corrosive fumes; it can react with reducing materials.
Storage and Handling: Section 7

3,5-DINITROBENZOYL CHLORIDE

Description: Yellow crystals.
Formula: $(NO_2)_2C_6H_3COCl$
Constants: Mol. Wt. 230.6
M. P. 69°C
B. P. 196°C @12 mm
Vap. D. 7.96
Toxic Hazard Ratings:
Acute Local: Irritant 3; Ingestion 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DINITRO-o-sec-BUTYL PHENOL

Description: Crystals.
Formula: $(NO_2)_2C_4H_7C_6H_4OH$
Constants:
Mol. Wt. 240.3
Vap. D. 7.73
Toxicity: Details unknown; an insecticide. See also Nitro Compounds of Aromatic Hydrocarbons.

Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

DINITROCAPRYL CROTONATE

Description: Crystals.
Formula: $(NO_2)_2CH(CH_2)_6CH_2O_2CCH{:}CHCH_3$
Constants:
- Mol. Wt. 288.3
- Vap. D. 9.95

Toxic Hazard Ratings:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DINITROCHLOROBENZENE

Synonym: 1-Chloro-2,4-dinitrobenzene.
Description: Yellow, rhombic crystals.
Formula: $(NO_2)_2C_6H_3Cl$
Constants:
- Mol. Wt. 202.56
- M. P. Alpha: 53.4°C; beta:43°C; gamma: 27°C
- B. P. 315°C
- Flash P. 382°F (C. C.)
- Density Alpha: 1.687@22°C; beta: 1.680 @20°/4°C
- Vap. D. 6.98

Toxic Hazard Ratings:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: Ingestion 3; Inhalation 3
- Chronic Local: U
- Chronic Systemic: Ingestion 3; Inhalation 3

Note: Chloronitrobenzenes are believed to be more toxic than nitrobenzenes, and the dinitro more toxic than the nitro. See also Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water; carbon dioxide; dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 1.97%-22%.
Disaster Control: See Nitrates.
Ventilation Control (use moderate rate).
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
- I. C. C. Classification: Poison B; poison label.
- Coast Guard Classification: Poison B; poison label.

DINITROCHLOROHYDRIN

Formula: $CH_2ClCHNO_2CH_2NO_2$
Constants:
- Mol. Wt. 168.6
- B. P. 180°C
- Density 1.5
- Vap. D. 5.83

Toxic Hazard Ratings:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: See Nitrates.
Explosion Hazard: Severe, when shocked.
Disaster Control: Dangerous; shock will explode it; when heated to decomposition, it burns and emits highly toxic fumes; it can react vigorously with reducing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

4,6-DINITRO-o-CRESOL

Synonym: 2-Methyl-4,6-dinitrophenol.
Description: Yellow, prismatic crystals.
Formula: $(NO_2)_2C_6H_2(CH_3)OH$
Constants:
- Mol. Wt. 198.1
- M. P. 85.8°C
- Vap. D. 6.82

Toxic Hazard Ratings:
- Acute Local: Irritant 3
- Acute Systemic: Ingestion 3; Inhalation 3
- Chronic Local: U
- Chronic Systemic: Ingestion 3; Inhalation 3

MAC: ACGIH (accepted); 0.03 part per million in air; 0.2 milligram per cubic meter of air.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

3, 5-DINITRO-o-CRESYL ACETATE

Formula: $CH_3COOC_6H_2CH_3(NO_2)_2$
Constants:
  Mol. Wt. 240.2
  Vap. D. 8.28
Toxicity: Details unknown. See also Cresol and Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

2, 4-DINITRO-6-CYCLOHEXYL PHENOL

Synonym: 2, 4-Dinitro-o-cyclohexyl phenol.
Description: Crystals.
Formula: $(NO_2)_2(C_6H_{11})OC_6H_3$
Constants:
  Mol. Wt. 266.3
  Vap. D. 8.62
Toxicity: Details unknown; probably toxic. See also Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

DINITRODICHLOROBENZENE

Description: Crystalline material.
Formula: $C_6H_2(NO_2)_2Cl_2$
Constants:
  Mol. Wt. 237.0
  Vap. D. 8.17
Toxic Hazard Ratings:
  Acute Local: Irritant 2
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: Ingestion 3; Inhalation 3
Fire Hazard: See Nitrates.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides and chlorides; it can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DINITROGEN TRIOXIDE

Synonym: Nitrous anhydride.
Description: Red-brown gas; blue solid or liquid.
Formula: N_2O_3
Constants: Mol. Wt. 76.02
  M. P. -102°C
  B. P. 3.5°C decomp.
  Density 1.447 @20°C
Toxic Hazard Ratings:
  Acute Local: Irritant 3; Inhalation 3
  Acute Systemic: Inhalation 3
  Chronic Local: U
  Chronic Systemic: Inhalation 3
MAC: AGGIH (accepted); 25 parts per million in air; 80 milligrams per cubic meter of air.
Disaster Control: See Nitric Oxide.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DINITROGLYCOL

Synonyms: Ethylene nitrate; diethylene glycol dinitrate.
Description: Liquid.
Formula: $C_2H_4(ONO_2)_2$
Constants:
  Mol. Wt. 152.1
  M. P. -20°C
  B. P. 98°C
  Density 1.2156 @ 0°/4°C
  Vap. D. 5.24
Toxicity: Details unknown. See Glycols.
Fire Hazard: See Nitrates.
Explosion Hazard: Severe, when shocked or heated to 114°C. Comparable to nitroglycerine. See also Explosives, High.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

DINITROMONOCHLORHYDRIN

Description: Dinitromonochlorhydrin is a high explosive miscible with nitroglycerine and is used

as a component in low-freezing dynamites and also in permissible gelatinous explosives.
Formula: $(NO_2)_2C_3H_5O_2Cl$
Constant:
Mol. Wt. 200.6
Toxicity: Unknown.
Fire Hazard: See Nitrates.
Explosion Hazard: See Explosives, High and Nitrates.
Disaster Control: See Explosives, High and Nitrates.
Storage and Handling: Section 7

DINITRONAPHTHALENE
Synonyms: (a) 1,5-Dinitronaphthalene; (b) 1,8-Dinitronaphthalene.
Description: (a) yellowish needles; (b) yellow, rhombic crystals.
Formula: $C_{10}H_6(NO_2)_2$
Constants:
Mol. Wt. 218.16
M. P. (a) 217.5°C; (b) 173-173.5°C
B. P. (a) Subl. (b) decomp.
Vap. D. 7.51
Toxicity: Details unknown. See also Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: Moderate, when shocked or exposed to heat. It is used mixed with chlorates and perchlorates and in combination with piciric acid. Dinitronaphthalene is an ingredient of permissible explosives and is also used in combination with ammonium nitrate.
Disaster Control: See Explosives, High and Nitrates.
Storage and Handling: Section 7

2,4-DINITRO-NAPHTHOL-1
Description: Yellow needles or leaflets.
Formula: $(NO_2)_2C_{10}H_5OH$
Constants:
Mol. Wt. 234.16
M. P. 138°C
Vap. D. 8.08
Toxicity: See Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

DINITRONAPHTHOL SALTS
Toxicity: See Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

2,4-DINITROPHENETOLE
Description: Crystals.
Formula: $(NO_2)_2C_6H_3OC_2H_5$
Constants:
Mol. Wt. 212.2
Vap. D. 7.32
Toxicity: Details unknown. See Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

2,3-DINITROPHENOL
Synonym: 1-Hydroxy-2,3-dinitrobenzene.
Description: Yellow needles.
Formula: $(NO_2)_2C_6H_3OH$
Constants:
Mol. Wt. 184.11
M. P. 144°C
Density 1.681 @20°C
Vap. D. 6.35
Toxic Hazard Ratings:
Acute Local: Irritant 3; Allergen1; Inhalation 2
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: Irritant 2; Allergen 2; Inhalation 2
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Toxicology: The harmful effects, which can be fatal, are damage to the liver and induced fever. Fatal cases have been reported in the literature from the inhalation of the dust in a concentration estimated at approximately 40 mg/cu. meter. It is a powerful stimulant of metabolism. It is the excessive oxidation effects of this material upon the metabololism and nutrition that damage the liver and kidney cells. Like other nitrated phenols, it is an irritant to the skin and has been known to cause dermatitis (Section 9). Ingestion will cause dilation of the pupils or posterior

subcapsular opacities or cataracts. It also exhibits some allergic manifestations. Wood preservative. See also Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: See Nitrates.
Explosion Hazard: Severe, when exposed to heat. A high explosive used as a component of some shell and bomb charges. See also Explosives, High.
Disaster Control: See Explosives, High and Nitrates.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

2,4-DINITROPHENOL
Description: Yellow crystals.
Formula: $(NO_2)_2C_6H_3OH$
Constants:
Mol. Wt. 184.11
M. P. 112°C
Density 1.683 @24°C
Vap. D. 6.35
Toxicity: See 2,3-Dinitrophenol.
Fire Hazard: See Nitrates.
Explosion Hazard: Moderate, when exposed to heat.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

2,6-DINITROPHENOL
Description: Yellow crystals.
Formula: $(NO_2)_2C_6H_3OH$
Constants:
Mol. Wt. 184.11
M. P. 63°C
Vap. D. 6.35
Toxicity: See 2,3-Dinitrophenol.
Fire Hazard: See Nitrates.
Explosion Hazard: Moderate, when exposed to heat.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

2,4-DINITROPHENYL ACETATE
Description: Crystals.
Formula: $CH_3CO_2C_6H_3(NO_2)_2$
Constants:
Mol. Wt. 228.2
Vap. D. 7.87
Toxicity: Details unknown. See Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

2,4-DINITRORESORCINOL
Synonyms: 2,4-Dinitro-1, 3-benzendiol; styphnic acid.
Description: Yellow crystals.
Formula: $(NO_2)_2C_6H_2(OH)_2$
Constants:
Mol. Wt. 200.11
M. P. 148°C
B. P. Sublimes and explodes
Vap. D. 6.79
Toxicity: Probably toxic. See Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: See Nitrates.
Explosion Hazard: Severe, when shocked or exposed to heat. Dinitroresorcinol and its lead salt are used in commercial priming compositions and blasting caps. It is also used to facilitate the ignition of lead azide. See also Explosives, High.
Disaster Control: See Explosives, High and Nitrates.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

1,4-DINITROSOPIPERAZINE
Description: White crystals.
Formula: $C_4H_8N_2(NO_2)_2$
Constants:
Mol. Wt. 144.1
M. P. 158°C
Vap. D. 4.97
Toxicity: Details unknown; a stomach insecticide.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

4,4'-DINITRO-2,2'-STILBENE DISULFONIC ACID
Description: Yellow paste or brownish crystals.
Constant:
Mol. Wt. 430
Toxicity: Unknown
Fire Hazard: See Nitrates.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen and sulfur; can react vigorously with reducing materials.
Storage and Handling: Section 7

2, 4-DINITROTOLUENE
Synonym: Dinitrotoluol.
Description: Yellow needles.
Formula: $(NO_2)_2C_6H_3CH_3$
Constants:
Mol. Wt. 182.13
M. P. 69.5°C
B. P. 300°C
Density 1.521 @15°C
Vap. D. 6.27
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 2; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: Allergen 2
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
MAC: ACGIH (accepted); 1.5 milligrams per cubic meter of air.
Fire Hazard: Moderate, when exposed to heat or flame; an oxidizer.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat.
Disaster Control: See Explosives, High and Nitrates.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DINOL. See Diazodinitrophenol.

DINONYL NAPHTHALENE
Description: Dark straw-colored viscous liquid.
Formula: $(C_9H_{19})_2C_{10}H_6$
Constants:
Mol. Wt. 380.6
B. P. 200 - 270°C @20 mm
Density 0.92-0.95 @30°/20°C
Vap. D. 13.1
Toxicity: Unknown
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials.
Storage and Handling: Section 7

DINONYL PHENOL
Description: Clear liquid.
Formula: $C_6H_3OH(C_9H_{19})_2$
Constants:
Mol. Wt. 346.6
B. P. 180 - 220°C @10 mm
Density 0.914 @25°C
Vap. D. 12.0
Toxicity: Details unknown. See also Phenols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride.
Storage and Handling: Section 7

DIOCTYL ADIPATE
Description: A clear liquid.
Formula: $(C_8H_{17}CO_2)_2C_4H_8$
Constants:
Mol. Wt. 370
B. P. 214°C @5 mm
Freezing P. −79°C
Flash P. 400°F (C.O.C.)
Density 0.924-0.930 @20°/20°C
Toxicity: See Esters and Adipic Acid.
Disaster Control: Slight; when heated, it emits acrid fumes; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIOCTYLAMINE
Description: Liquid.
Formula: $(C_8H_{17})_2NH$
Constants:
Mol. Wt. 241.5
B. P. 280°C
Flash P. 270°F
Density 0.8
Vap. Press. 0.01 mm @20°C
Toxicity: Details unknown. See also Amines.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIOCTYLCHLOROPHOSPHATE
Description: Liquid.
Formula: $(C_8H_{17}O)_2POCl$
Constants:
Mol. Wt. 341
B. P. 125°C @0.2 mm
Density 0.9839 @25°/25°C

Toxicity: Details unknown; an insecticide.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus and chlorides.
Storage and Handling: Section 7

DI(n-OCTYL, n-DECYL) PHTHALATE

Description: Clear, oily liquid.
Formula: $C_{26}H_{42}O_2$
Constants:
Mol. Wt. 418.3
B. P. 232 - 267°C @5 mm
Freezing P. −30°C
Flash P. 426°F (O. C.)
Density 0.968-0.977 @25°/25°C
Vap. D. 14.4
Toxicity: See Esters.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIOCTYL FUMARATE

Synonym: Di-2-ethyl hexyl fumarate.
Description: Clear, mobile liquid; mild odor.
Formula: $(C_8H_{17}CO_2)_2C_2H_2$
Constants:
Mol. Wt. 340
B. P. 211 - 220°C
Flash P. 365°F (C.O.C.)
Density 0.942 @20°/20°C
Toxicity: See Esters and Fumaric Acid.
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIOCTYL PHOSPHITE

Formula: $(C_8H_{17}O)_2PHO$
Constants:
Mol. Wt. 306.3
B. P. 128°C @0.5 mm
Density 0.9291 @25°/25°C
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus.
Storage and Handling: Section 7

DIOCTYL PHTHALATE. See Di-2-Ethyl Hexyl Phthalate.

DIOCTYL SEBACATE

Description: Liquid.
Formula: $[(CH_2)_4CO_2C_8H_{17}]_2$
Constants:
Mol. Wt. 426.7
M. P. −55°C
B. P. 248°C @4 mm
Flash P. 465°F
Density 0.916 @20°/20°C
Toxicity: See Esters.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIOCTYL SODIUM SULFOSUCCINATE

Description: White solid or clear, viscous liquid.
Formula:
$C_8H_{17}CO_2CH_2CHCO_2C_8H_{17}SO_3Na$
Constant:
Mol. Wt. 444
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: Irritant 1; Ingestion 1; Inhalation 1
Chronic Systemic: U
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIOCTYLTETRAHYDROPHTHALATE

Description: Crystals.
Formula: $C_6H_8(COOC_8H_{17})_2$
Constants:
Mol. Wt. 394.6
Vap. D. 13.6
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed

to heat or flame; can react with oxidizing materials (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIONIN

Synonym: Ethylmorphine hydrochloride.
Description: White, microscopic, crystalline powder.
Formula: $C_{19}H_{23}NO_3 \cdot HCl \cdot 2H_2O$
Constants:
  Mol. Wt. 385.88
  M. P. 125°C Decomposes
  Vap. D. 13.3
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: Ingestion 3
  Chronic Local: Allergen 1
  Chronic Systemic: U
Caution: May cause habituation. See also Codeine.
Fire Hazard: Slight; when heated, it emits smoke (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

1,4-DIOXANE

Synonyms: p-Dioxane; diethylene oxide; diethylene dioxide.
Description: Colorless liquid.
Formula: $OCH_2CH_2OCH_2CH_2$
Constants:
  Mol. Wt. 88.10
  M. P. 10°C
  B. P. 101.1°C
  Flash P. 54°F (C.C.)
  Density 1.0353 @20°/4°C
  Autoign. Temp. 356°F
  Vap. Press. 40 mm @25.2°C
  Vap. D. 3.03
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 2
  Chronic Local: U
  Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 2
MAC: ACGIH (accepted): 100 parts per million in air; 360 milligrams per cubic meter of air.
Toxicology: Exposure of animals to concentrations of 0.1 to 3% of dioxane vapor causes irritation of the eyes and nose, followed by narcosis and/or pulmonary edema and death. The irritative effects probably provide sufficient warning, in acute exposures, to enable the workman to leave exposure before he is seriously affected. On the other hand, repeated exposure to low concentrations has resulted in human fatalities, the organs chiefly affected being the liver and kidneys. Death resulted from acute hemorrhagic nephritis. The hepatic lesion consists of an acute central necrosis of the lobules. The brain and lungs may show acute edema.

In acute exposures, the signs and symptoms consist of irritation of the eyes and naso-pharynx, which may later subside, to be followed by headache, drowsiness, dizziness, and occasionally nausea and vomiting. In chronic exposures, there may be loss of appetite, nausea and vomiting, pain and tenderness in the abdomen and lumbar region, malaise, and enlargement of the liver without jaundice. There may be changes in the blood picture. Further exposure may result in suppression of urine, followed by uremia and death.

Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame or by chemical reaction with oxidizers.
Explosive Range: 1.97 - 22.2%
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

DIOXOLANE

Description: Water-white liquid.
Formula: $\underline{OCH_2CH_2OCH_2}$
Constants:
  Mol. Wt. 74.08
  M. P. -26.4°C
  B. P. 74°C
  Flash P. 35°F (O.C.)
  Density 1.065
  Vap. Press. 70 mm @20°C
Toxic Hazard Rating:
  Acute Local: U

Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous! Keep away from heat and open flame!
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIPENTAERYTHRITOL

Description: White powder; odorless.
Formula: $C_{10}H_{22}O_7$
Constants:
Mol. Wt. 254.3
M. P. 212 - 220°C
Density 1.33 @25°/4°C
Vap. D. 8.77
Toxicity: Details unknown
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

DIPENTENE

Synonym: Cinene.
Description: Colorless liquid, pleasant, lemon-like odor.
Formula: $C_{10}H_{16}$
Constants:
Mol. Wt. 136.23
B. P. 174.6°C
Flash P. 108°F
Density 0.865 @18°C; 0.845 @ 20°C
Vap. Press. 1 mm @14.0°C
Vap. D. 4.66
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 1; Ingestion 2; Inhalation 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIPHENYL

Synonym: Biphenyl.
Description: White scales, pleasant odor.
Formula: $C_6H_5C_6H_5$
Constants:
Mol. Wt. 154.2
M. P. 70°C
B. P. 255°C
Flash P. 235°F (C.C.)
Density 0.991 @75°/4°C
Autoign. Temp. 498°F
Vap. D. 5.31
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIPHENYLACETIC ACID

Synonym: Diphenylmethane α-carboxylic acid.
Description: White crystals.
Formula: $(C_6H_5)_2CHCOOH$
Constants:
Mol. Wt. 212.2
M. P. 147 - 148.2°C
B. P. Sublimes
Vap. D. 7.3
Toxicity: Details unknown. See also Diphenyl.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

DIPHENYLAMINE

Synonym: Phenylaniline; anilinobenzene.
Description: Liquid.
Formula: $(C_6H_5)_2NH$
Constants:
Mol. Wt. 169.24

M. P. 52.9°C
B. P. 302.0°C
Flash P. 307°F (C. C.)
Density 1.16
Autoign. Temp. 846°F
Vap. Press. 1 mm @108.3°C
Vap. D. 5.82
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DIPHENYLAMINE ARSENIOUS OXIDE

Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

DIPHENYLAMINECHLOROARSINE

Synonym: Adamsite.
Description: Light yellow to green granules, irritant odor.
Formula: $NH(C_6H_4)_2AsCl$
Constants:
Mol. Wt. 277.6
M. P. 195°C
B. P. 410°C (Decomposes)
Density 1.65
Vap. Press. Very low @20°C
Vap. D. 9.6
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3
Caution: A vomiting type of military poison and a non-persistent military gas. See also Arsenic Compounds.
Disaster Control: Dangerous; when heated it emits highly toxic fumes of arsenic.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison C (gas, liquid or solid); tear gas label.
Coast Guard Classification: Poison C (gas, liquid or solid); tear gas label.

DIPHENYLBROMOARSINE

Description: Crystals.
Formula: $(C_6H_5)_2AsBr$
Constants: Mol. Wt. 309.1
M. P. 54°C
Vap. D. 10.7
Toxic Hazard Rating:
Acute Local: Irritant 3; Allergen 1; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Allergen 1
Chronic Systemic: Ingestion 3; Inhalation 3
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated, it emits highly toxic fumes of arsenic.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DIPHENYLCHLOROARSINE

Description: Colorless crystals when pure; technical product is dark brown liquid.
Formula: $(C_6H_5)_2AsCl$
Constants:
Mol. Wt. 264.57
B. P. 333°C (Decomposes)
Freezing P. 44°C

Density 1.363 @40°C (solid): 1.358 @45°C (liquid)
Vap. Press. 0.00049 mm @20°C
Vap. D. 9.15

Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3

Caution: A powerful irritant military poison. Can be decontaminated by use of chlorine or caustic soda in confined spaces.

Toxicology: A non-persistent gas. Exposure yields cold-like symptoms, plus headache, vomiting and nausea. Relatively nontoxic to eyes and skin, mainly an irritant.

Disaster Control: Dangerous: when heated it emits highly toxic fumes of arsenic.

Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Poison C; tear gas label.
Coast Guard Classification (solid): Poison C; tear gas label.

DIPHENYLCYANOARSINE

Description: Colorless prisms, characteristic odor resembling that of a mixture of bitter almonds and garlic.

Formula: $(C_6H_5)_2AsCN$

Constants:
Mol. Wt. 255.0
B. P. 213°C @21 mm
Freezing P. 31°C
Density 1.33 @20°C
Vap. Press. 0.0002 mm @20°C
Vap. D. 8.75

Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3

Toxicology: Acts as an irritant only to the eyes. Exposure yields cold-like symptoms, plus headache, vomiting and nausea. A vomiting gas of the non-persistent variety. Decontamination needed only in confined spaces by alkali solution. See also Cyanides and Arsenic Compounds.

Disaster Control: Dangerous; when heated, it emits highly toxic fumes of cyanides and arsenic.

Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DIPHENYLDICHLOROSILANE

Description: Colorless liquid.

Formula: $(C_6H_5)_2SiCl_2$

Constants:
Mol. Wt. 245.22
M. P. −22°C
B. P. 303°C
Density 1.19 @20°C
Vap. D. 8.45

Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U

Disaster Control: Moderately dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits toxic fumes; will react with water or steam to produce heat, toxic and corrosive fumes; can react vigorously with oxidizing materials.

Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

DIPHENYL DISULFIDE

Description: White powder.

Formula: $C_6H_5\text{-}S\text{-}S\text{-}C_6H_5$

Constants: Mol. Wt. 218.3
M. P. 59.5 - 60.0°C
B. P. 310°C

Toxicity: Details unknown

Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

DIPHENYLENE OXIDE
Synonym: Dibenzofuran.
Description: Colorless crystals.
Formula: $\underline{C_6H_4OC_6H_4}$
Constants:
Mol. Wt. 168.2
M. P. 87°C
B. P. 288°C
Vap. D. 5.8
Toxicity: Details unknown; an insecticide.
Fire Hazard: Slight; when heated it emits acrid fumes.
Storage and Handling: Section 7

1,1-DIPHENYL ETHANE
Description: Pale, yellowish liquid, aromatic odor.
Formula: $C_6H_5CHCH_3C_6H_5$
Constants: Mol. Wt. 182.3
M. P. −20°C
B. P. 272°C
Flash P. 264°F
Density 0.987 @25°/25°C
Vap. D. 6.28
Toxicity: Details unknown. See also Diphenyl.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

DI-beta-PHENYLETHYLAMINE
Description: Colorless to slightly yellow liquid.
Formula: $(C_6H_5CH_2CH_2)_2NH$
Constants:
Mol. Wt. 225.3
B. P. 204°C @22 mm
Density 1.0 @25°/25°C
Vap. D. 7.76
Toxicity: Details unknown. See also Amines.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

DIPHENYLGUANIDINE
Description: White powder.
Formula: $NH{:}C(NHC_6H_5)_2$
Constants:
Mol. Wt. 211.1
M. P. 145°C
Density 1.15 @25°C
Toxicity: Details unknown.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

DIPHENYLGUANIDINE PHTHALATE
Description: White to light gray powder.
Formula: $C_6H_4(COOH)_2$-$[HNC(NHC_6H_5)_2]_2 \cdot {}^1/_2H_2O$
Constants:
Mol. Wt. 604.7
M. P. 178°C
Density 1.2 @25°C
Toxicity: Details unknown. See also Esters.
Fire Hazard: Slight; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

DIPHENYLMETHANE
Synonym: Benzylbenzene.
Description: Liquid.
Formula: $(C_6H_5)_2CH_2$
Constants:
Mol. Wt. 168.23
M. P. 26.5°C
B. P. 264.5°C
Flash P. 266°F (C.C.)
Density 1.006
Vap. Press. 1 mm @76.0°C
Vap. D. 5.79
Toxicity: Details unknown. See also Benzene.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIPHENYLMETHANE DIISOCYANATE. See Methylene bis-(4-Phenyl Isocyanate).

DIPHENYL MONO-(para-tert BUTYL PHENYL) PHOSPHATE
Synonym: para-tert-Butyl phenyl diphenyl phosphate.
Description: Colorless to pale straw-colored liquid.
Formula: $(C_6H_5)_2[(CH_3)_3CC_6H_4]PO_4$
Constants:
Mol. Wt. 382.4
B. P. 245 - 260°C @5 mm
Freezing P. 0°C
Flash P. 435°F
Density 1.16 @25°/25°C
Toxicity: Details unknown
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

DIPHENYL OXIDE.
Synonym: Diphenyl ether.
Description: Colorless crystals, geranium odor.
Formula: $(C_6H_5)_2O$
Constants:
Mol. Wt. 170.20
M. P. 28°C
B. P. 257°C
Flash P. 205°F
Density 1.0728 @20°C
Vap. D. 5.86
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Spontaneous Heating: No
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride. See also Ethers.
Explosion Hazard: See Ethers.
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

N,N-**DIPHENYL**-para-**PHENYLENEDIAMINE**
Description: Solid.
Formula: $(C_6H_5)_2NC_6H_4NH_2$
Constants: Mol. Wt. 260.3
Density 1.20
Vap. D. 9.0
Toxicity: A weak allergen. See also p-Phenylenediamine.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

DIPHENYL PHTHALATE
Description: Liquid.
Formula: $C_6H_4(COOC_6H_5)_2$
Constants:
Mol. Wt. 318.3
M. P. 70.7°C
B. P. 405°C
Flash P. 435°F (C.C.)
Density 1.28
Toxicity: Moderate. See Phenol and Phthalic Acid.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

N,N'-**DIPHENYL PIPERAZINE**
Description: Crystals.
Formula: $C_6H_5N(CH_2)_4NC_6H_5$
Constants:
Mol. Wt. 238.3
M. P. 167°C
Vap. D. 8.22
Toxicity: Details unknown; piperazines generally have a low order of toxicity.
Storage and Handling: Section 7

1,4-**DIPHENYLSEMICARBAZIDE**
Description: Crystals.
Formula:
$C_6H_5NHNHCONHC_6H_5$
Constants:
Mol. Wt. 227.3
Vap. D. 7.8
Toxicity: Details unknown; an insecticide.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

DIPHENYL SULFOXIDE
Description: Crystals.
Formula: $(C_6H_5)_2SO$
Constants:
Mol. Wt. 202.3
Vap. D. 7.0
Toxicity: Details unknown. A fungicide. See also Diphenyl.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

1,3-**DIPHENYL**-2-**THIOUREA.** See Thiocarbanilide.

DIPHOSGENE
Synonym: Trichloromethyl chloroformate.
Description: Colorless liquid, odor of phosgene.
Formula: $ClCO_2CCl_3$
Constants:
Mol. Wt. 197.9
M. P. -57°C
B. P. 128°C
Density 1.653 @14°/4°C
Vap. Press. 10.3 mm @20°C
Vap. D. 6.9
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Toxicology: A military poison. A lung irritant. It is but slightly lachrimatory. Its physiological action like phosgene is delayed. To decontaminate in enclosed spaces, use ammonia or steam. It is moderately persistent. See also Phosgene.
Disaster Control: Dangerous; when heated, it emits highly toxic fumes; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Poison A; poison gas label.
Coast Guard Classification: Poison A; poison gas label.

DIPICRYL AMINE
Synonym: 2,4,6,2',4',6'-Hexanitrodiphenylamine.
Description: Yellow crystals.
Formula: $C_{12}H_5O_{12}N_7$
Constants:
Mol. Wt. 439.2
M. P. 238°C Decomposes
Toxicity: Details unknown. See also Amines.
Explosion Hazard: Moderate, when exposed to heat (Section 7).
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes and explodes.
Storage and Handling: Section 7

1,10-**DIPIPERIDINEDECANE**
Description: Solid.
Formula:
$(CH_2)_5NCH_2(CH_2)_8CH_2N(CH_2)_5$
Constants:
Mol. Wt. 308.5
Vap. D. 10.7
Toxicity: Details unknown. Piperidines usually have a low toxicity.
Storage and Handling: Section 7

DIPOTASSIUM NITROACETATE
Description: Solid.
Formula: $K_2(NO_2)C_2O_2H$
Constant:
Mol. Wt. 181.2
Toxicity: Unknown
Explosion Hazard: Severe, when shocked or exposed to heat (Section 7).
Disaster Control: Highly dangerous; shock and heat will explode it; when heated to decomposition, it emits highly toxic fumes.
Storage and Handling: Section 7

DIPROPARGYL
Synonym: 1,5-Hexadiyne.
Description: Colorless liquid.
Formula: $CH\vdots CCH_2CH_2C\vdots CH$
Constants:
Mol. Wt. 78.1
B. P. 86°C
Freezing P. -6°C
Density 0.8049 @20°/4°C
Vap. D. 2.69
Toxicity: Details unknown.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).

Explosion Hazard: Moderate, when exposed to heat (Section 7).
Disaster Control: Moderately dangerous; when heated to decomposition it explodes; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

DI-n-PROPYLAMINE
Synonym: Dipropyl amine.
Description: Water-white, amine odor.
Formula: $(C_3H_7)_2NH$
Constants:
Mol. Wt. 101.19
M. P. −40°C
B. P. 221°F
Flash P. 45°F
Density 0.741 @20°C
Toxicity: Details unknown. See also Amines.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous! Keep away from heat and open flame!
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

DIPROPYL BERYLLIUM
Description: Liquid.
Formula: $Be(C_3H_7)_2$
Constants:
Mol. Wt. 95.19
M. P. < −17°C
B. P. 245°C
Vap. D. 3.29
Toxicity: See Beryllium Compounds.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of beryllium oxide; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DIPROPYLENE GLYCOL
Synonym: 2,2'-Dihydroxy isopropyl ether.
Description: Colorless, slightly viscous liquid. Practically no odor.
Formula: $(CH_3CHOHCH_2)_2O$
Constants:
Mol. Wt. 134.17
B. P. 231.8°C
Freezing P. None
Flash P. 244°F (T.O.C.)
Density 1.0252 @20°/20°C
Vap. Press. 1 mm @73.8°C
Vap. D. 4.63
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2
Chronic Local: U
Chronic Systemic: Ingestion 1; Inhalation 1
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use optional): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIPROPYLENE GLYCOL DIBENZOATE
Description: Liquid.
Formula: $CH_3CHC_6H_5CO_2CH_2O$-$CH_2CHC_6H_5CO_2CH_3$
Constants:
Mol. Wt. 342.4
M. P. < −30°C (sets to a glass)
B. P. 250°C @10 mm
Density 1.1260 @20°/20°C
Vap. Press. 1.2 mm @200°C
Vap. D. 11.8
Toxicity: See Glycols and Benzoic Acid.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

DIPROPYLENE GLYCOL DIMETHYL ETHER
Description: Liquid.
Formula: $CH_3OC_3H_6OC_3H_6OCH_3$
Constants:
Mol. Wt. 148.2
B. P. 190°C
Density 0.951
Vap. D. 5.11
Toxicity: Details unknown. See also Glycols.

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

DI(PROPYLENE GLYCOL) 4,4'-ISOPROPYLIDENE BISPHENYL

Description: Very viscous liquid.
Formula:
$(CH_3CHOHCH_2OC_6H_4)_2C_3H_6$
Constants:
Mol. Wt. 344.4
M. P. 54°C
B. P. Decomposes
Flash P. 450°F
Density 1.058 @ 80°/4°C
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIPROPYLENE GLYCOL METHYL ETHER

Description: Colorless liquid.
Formula: $CH_3OC_3H_6OC_3H_6OH$
Constants:
Mol. Wt. 148.2
B. P. 189°C
Flash P. 185°F
Density 0.950 @25°/4°C
Vap. D. 5.11
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIPROPYLENE GLYCOL MONOMETHYL ETHER

Synonym: Dowanol 50B
Description: Liquid.
Formula: $CH_3OC_3H_6OC_3H_6OH$
Constants:
Mol. Wt. 148.2
M. P. Doesn't crystallize
B. P. 190°C
Flash P. 185°F
Density 0.951 @25°/25°C
Vap. D. 5.11
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIPROPYLENE GLYCOL PHENYL ETHER

Description: Slightly yellow liquid.
Formula: $C_6H_5OC_3H_6OC_3H_6OH$
Constants:
Mol. Wt. 210.2
M. P. < -25°C
B. P. 285.7°C
Flash P. 315°F
Density 1.044 @25°/25°C
Vap. D. 7.25
Toxicity: See Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride. See also Ethers.
Explosion Hazard: Details unknown. See also Ethers.
Storage and Handling: Section 7

DIPROPYLENE TRIAMINE

Description: Water-white liquid.
Formula:
$(CH_3)_2(CH_2)_2(CH_2)_2(NH_2)_2NH$
Constants:
Mol. Wt. 133.2
Flash P. 190°F
Density 0.96
Vap. D. 4.6
Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIPROPYL KETONE

Synonym: Butyrone.
Description: Colorless, refractive liquid.
Formula: $C_7H_{14}O$
Constants: Mol. Wt. 114.2
B. P. 144°C
Freezing P. -32.6°C
Flash P. 120°F
Density 0.821 @15°/4°C

Vap. Press. 5.2 mm @20°C
Vap. D. 3.93
Toxicity: See Ketones.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DI-n-PROPYLPHOSPHOTHIONIC CHLORIDE

Formula: $(n\text{-}C_3H_7O)_2PSCl$
Constants:
Mol. Wt. 216.67
B. P. 70 - 75°C @1 mm
Density 1.123 @25°/4°C
Toxicity: Details unknown
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of phosphorus and sulfur.
Storage and Handling: Section 7

DIPROPYL PHTHALATE

Description: Liquid.
Formula: $C_6H_4(COOC_3H_7)_2$
Constants:
Mol. Wt. 250.28
B. P. 129 - 132°C @1 mm
Density 1.071 @25°C
Toxicity: See Esters, Phthalic Acid and Propyl Alcohol.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical, or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2, 2'-DIPYRIDYLAMINE

Description: Crystal.
Formula: $C_{10}H_9N_3$
Constants:
Mol. Wt. 171.2
M. P. 95.3°C
B. P. 222°C
Toxicity: Details unknown
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

DIPYRIDYL ETHYL SULFIDE

Description: Liquid
Formula: $H_4NC_5(CH_2)_2S(CH_2)_2C_5NH_4$
Constants:
Mol. Wt. 241.4
M. P. 1.5°C
Density 1.113 @25°C
Vap. D. 8.31
Toxicity: Details unknown; an insecticide.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur and nitrogen.
Storage and Handling: Section 7

DISALICYLAL PROPYLENE DIIMINE

Synonym: Schiff's Base.
Formula:
$HOC_6H_4CHNHC_2CHCH_3NHCC_6H_4OH$
Constants:
Mol. Wt. 282.3
M. P. -23.3°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

DISILANE

Synonym: Silicoethane.
Description: Gas, repulsive odor.
Formula: Si_2H_6
Constants:
Mol. Wt. 62.2
M. P. -132.5°C
B. P. -14.5°C
Density 0.686 @-25°/4°C
Toxicity: Details unknown. See also Hydrides.
Fire Hazard: Dangerous, when exposed to heat or flame or by chemical reaction; can react with oxidizing materials. Ignites spontaneously in air (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7

DISILICON HEXABROMIDE

Synonym: Hexabromodisilane.
Description: Rhombic, white crystals.
Formula: Si_2Br_6

Constants:
  Mol. Wt. 535.62
  M. P. 95°C
  B. P. 240°C
  Vap. D. 18.5
Toxicity: See Bromides and Silanes.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromides; will react with water or steam to produce heat, toxic and corrosive fumes.
Storage and Handling: Section 7

DISILICON HEXACHLORIDE

Synonym: Hexachlorodisilane.
Description: Colorless liquid.
Formula: Si_2Cl_6
Constants:
  Mol. Wt. 268.86
  M. P. −1°C
  B. P. 139°C
  Density Liquid: 1.58 @ 0°C
  Vap. D. 9.29
Toxicity: Details unknown. See also Silanes.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

DISILICON HEXAFLUORIDE

Synonym: Hexafluorodisilane.
Description: Gas.
Formula: Si_2F_6
Constants:
  Mol. Wt. 170.12
  M. P. −18.7°C
  B. P. −19.1°C Sublimes
  Vap. D. 5.87
Toxicity: See Fluorides and Silanes.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

DISILICON HEXAIODIDE

Synonym: Hexaiododisilane.
Description: Hexagonal, colorless crystals.
Formula: Si_2I_6
Constants:
  Mol. Wt. 817.64
  M. P. 250°C
  B. P. Decomposes
  Vap. D. 28.2
Toxicity: Details unknown. See Iodides and Silanes.
Disaster Control: Dangerous; on decomposition, it emits highly toxic fumes of iodides; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

DISILICON TETRAIODIDE

Synonym: Tetraiododisilane-ethylene.
Description: Orange-red crystals.
Formula: Si_2I_4
Constants:
  Mol. Wt. 563.80
  Vap. D. 19.4
Toxicity: Details unknown. See Iodides and Silanes.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of iodine; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

DISODIUM ACETOARSENATE

Synonym: Aricyl.
Description: White, crystalline powder.
Formula: $COONaCH_2AsOOHONa$
Constant:
  Mol. Wt. 227.95
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

DISODIUM ETHYLENEDIAMINE TETRAACETATE

Synonyms: Sequestrene; ethylenediamine tetracetic acid.
Description: White crystals.
Formula: $C_{10}H_{14}O_8Na_2 \cdot 2H_2O$
Constants:
  Mol. Wt. 372
  Vap. D. 12.8
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1; Inhalation 1
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: Ingestion 1
Fire Hazard: Slight; when heated, it emits smoke (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

DISPERSANT GAS, N.O.S.

Description: Gas.

Toxicity: Unknown
Shipping Regulations: Section 11.
I. C. C. Classification: Nonflammable gas; green label.
Coast Guard Classification: Noninflammable gas; green gas label.

DISULFUR DECAFLUORIDE See Sulfur Pentafluoride.

DITAINE
Synonym: Echitamine.
Description: White, thick, glistening, crystalline alkaloid.
Formula: $C_{22}H_{28}N_2O_4 \cdot 4H_2O$
Constants:
Mol. Wt. 456.53
M. P. 206°C Decomposes
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

DITCH POWDER. See Explosives, High.

2, 3-**DITHIABUTANE**
Synonym: Dimethyl disulfide.
Description: Liquid.
Formula: $CH_3\text{-}S\text{-}S\text{-}CH_3$
Constants:
Mol. Wt. 94.2
B. P. 109.7°C
Density 1.0569 @25°C
Vap. Press. 28.6 mm @25°C
Vap. D. 3.24
Toxicity: Details unknown.
Fire Hazard: Moderate (Section 6).
Disaster Control: Dangerous; when heated to decomposition, or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

3, 4-**DITHIAHEXANE**
Synonym: Diethyl disulfide.
Description: Liquid.
Formula: $C_2H_5\text{-}S\text{-}S\text{-}C_2H_5$
Constants:
Mol. Wt. 122.3
B. P. 154°C
Freezing P. −101.5°C
Density 0.99267 @20/4°C
Vap. D. 4.22
Vap. Press. 4.28 mm @25°C
Toxicity: Details unknown.
Fire Hazard: Moderate (Section 6).
To Fight Fire: Foam, carbon tetrachloride, dry chemical.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

1, 3-**DITHIANE,** 2, 2-**DIPHENYL**
Synonym: 1, 3-Diethylene disulfide-2, 2-diphenyl.
Description: Crystals.
Formula: $S[CH_2C(C_6H_5)_2CH_2CH_2]S$
Constants:
Mol. Wt. 272.4
Vap. D. 9.4
Toxicity: Details unknown.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

2, 2'-**DITHIOBIS (BENZOTHIAZOLE).** See 2, 2'-Benzothiazole Disulfide.

DITHIOBIURET
Description: Crystals.
Formula: $H_2NC(S)NHC(S)NH_2$
Constants:
Mol. Wt. 135.20
M. P. 181°C
B. P. Decomposes
Density 1.522 @30°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

DITHIOCARBAMIC ACID
Synonym: Amino dithioformic acid.
Description: Colorless needles.
Formula: NH_2CS_2H
Constants:
  Mol. Wt. 93.2
  Vap. D. 3.21
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1; Inhalation 1
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: Ingestion 1; Inhalation 1
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

beta-**DITHIOCYANOETHYL ETHER**
Formula: $O[C(CNS)_2CH_3]_2$
Constants:
  Mol. Wt. 302.5
  Vap. D. 10.4
Toxicity: Details unknown; an insecticide.
Fire Hazard: Moderate (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

DI-ortho-**TOLYLGUANIDINE**
Description: White crystals.
Formula: $C_{15}H_{17}N_3$
Constants:
  Mol. Wt. 239.3
  M. P. 179°C
  Density 1.10 @20°/4°C
  Vap. D. 8.24
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen.
Personal Hygiene: Section 3
Storage and Handling: Section 7

DI-ortho-**TOLYLTHIOUREA**
Synonym: Sym-di-o-tolylthiourea.
Description: Crystals.
Formula: $CS(NHC_6H_4CH_3)_2$
Constants:
  Mol. Wt. 256.4
  M. P. 178°C
  Vap. D. 8.85
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

2,2-**DI**-para-**TOLYL**-1,1,1-**TRICHLOROETHANE**
Description: Crystals.
Formula: $(C_6H_4CH_3)_2C_2HCl_3$
Constants:
  Mol. Wt. 313.7
  Vap. D. 10.8
Toxicity: Probably toxic. An insecticide. See also Chlorinated Hydrocarbon Insecticides and DDT.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

1,2-**DIVALERATE DIETHYL SULFIDE**
Description: Liquid.
Formula:
  $[CH_2(COOC_4H_9)CH(COOC_4H_9)]_2S$
Constants:
  Mol. Wt. 490.64
  M. P. -45°C
  B. P. 246°C @5 mm
  Flash P. 430°F (O. C.)
  Density 1.0543 @20°/20°C
  Vap. D. 16.95
Toxicity: Details unknown.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur; can react with oxidizing materials.
Storage and Handling: Section 7

DIVINYL-b. See 1,3-Butadiene.

meta-DIVINYL BENZENE
Synonym: Vinylstyrene.
Description: Water-white liquid.
Formula: $C_6H_4(CHCH_2)_2$
Constants:
Mol. Wt. 130.1
B. P. 199.5°C
Freezing P. -66.9°C
Flash P. 165°F
Density 0.9289 @20°C
Vap. Press. 1 mm @32.7°C
Vap. D. 4.48
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Inhalation 2
Chronic Local: U
Chronic Systemic: Inhalation 2
Fire Hazard: Moderate, when exposed to heat or flame or by spontaneous chemical reaction; can react with oxidizing materials.
Spontaneous Heating: Yes.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6). Commercial DVB without inhibitor may start to polymerize and gel. Heat can then build up rapidly to possibly 300°C and the vapor pressure may attain dangerous levels. In storage this material should be kept below 90°F possibly by water spray.
Explosion Hazard: Moderate, in the form of vapor when exposed to flame (Section 7).
Explosive Range: 0.3% (L.E.L.)
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

DIVINYL ETHER. See Vinyl Ether.

DI (VINYL OCTYLATE) CAPRYLAMIDE
Description: Liquid.
Formula: $(C_7H_{15}COOC_2H_4)_2NCOC_7H_{15}$
Constants:
Mol. Wt. 483.71
M. P. -33°C
B. P. 256°C @5 mm
Flash P. 420°C
Density 0.9564 @20°/20°C
Vap. D. 16.7
Toxicity: Unknown
Fire Hazard: Slight when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DIVINYL OXIDE. See Vinyl Ether.

DIVINYL PYRETHRIN I
Synonyms: DVPy; allyl homolog of Cinerin I.
Toxic Hazard Rating:
Acute Local: Ingestion 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

DIVINYL SULFIDE
Description: Mobile liquid, characteristic odor.
Formula: $(CHCH_2)_2S$
Constants:
Mol. Wt. 862
B. P. 86°C
Density 0.9174 @15°C
Vap. D. 2.97
Toxicity: Details unknown.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; on contact with oxidizing materials, it can react vigorously.
Storage and Handling: Section 7

"DM"
Synonyms: Diphenylamine chloroarsine; phenarsazine chloride.
Description: Canary yellow crystals.
Formula: $C_{12}H_9AsClN$
Constants: Mol. Wt. 277.57
M. P. 195°C
B. P. 410°C
Vap. D. 9.3
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Allergen 2
Chronic Systemic: Ingestion 3; Inhalation 3
Disaster Control: Dangerous; when heated to decompositon or on contact with acid or acid fumes, it emits highly toxic fumes

of arsenic and chlorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

DODECANE
Synonym: Dihexyl.
Description: Liquid.
Formula: $C_{12}H_{26}$
Constants:
Mol. Wt. 170.3
M. P. −12°C
B. P. 216.2°C
Flash P. 165°F
Density 0.750
Vap. Press. 1 mm @47.8°C
Vap. D. 5.96
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, in the form of vapor when exposed to flame (Section 7).
Explosive Range: 0.6% (L.E.L.)
Disaster Control: Dangerous; keep away from heat and open flame.
Storage and Handling: Section 7

DODECENE
Synonym: Dodecylene.
Description: Colorless liquid.
Formula: $C_{12}H_{24}$
Constants:
Mol. Wt. 168.31
M. P. −31.5°C
B. P. 213°C
Density 0.76@ 20°/4°C
Vap. Press. 1 mm @47.2°C
Vap. D. 5.81
Toxicity: Details unknown.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DODECENYL SUCCINIC ANHYDRIDE
Description: Light, yellow, clear viscous oil.
Formula: $C_{12}H_{23}\underline{CHCOOOCC}H_2$
Constants:
Mol. Wt. 266
B. P. 180 - 182°C @5 mm
Flash P. 352°F (C.O.C.)
Density 1.002 @25°/4°C
Toxicity: Details unknown.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DODECYLBENZENE, CRUDE
Description: Liquid.
Formula: $C_{12}H_{25}C_6H_5$
Constants:
Mol. Wt. 246.4
B. P. 290 - 410°C
Flash P. 285°F
Density 0.9
Vap. D. 8.47
Toxicity: Details unknown. See also Benzene.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DODECYL MERCAPTAN
Synonym: Lauryl mercaptan.
Description: Colorless liquid.
Formula: $C_{12}H_{25}SH$
Constants: Mol. Wt. 202.4
B. P. 143°C
Vap. D. 6.97
Toxicity: Details unknown. See also Mercaptans.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

tert-DODECYL MERCAPTAN
Description: White to light yellow liquid.
Formula: $C_{12}H_{25}SH$
Constants:
Mol. Wt. 202.4
B. P. 200 - 235°C

Flash P. 205°F
Density 0.85 @25°/25°C
Vap. D. 6.98
Toxicity: Probably toxic. See also Mercaptans.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

DODECYL PHENOL
Description: Straw-colored liquid, phenolic odor.
Formula: $C_{12}H_{25}C_6H_4OH$
Constants:
Mol. Wt. 262.4
B. P. 310 - 335°F
Flash P. 250°F
Density 0.93 @20°/20°C
Vap. D. 9.04
Toxicity: Probably toxic. See Phenol.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

DRILL CARTRIDGES. See Explosives, High.
Shipping Regulations: Section 11.
Coast Guard Classification: No restrictions.

DRUMS, EMPTY (USED)
Shipping Regulations: Section 11.
Coast Guard Classification: Hazardous material.

"DRYOLENE"
Synonym: (V M & P)
Description: Water-white liquid.
Constants:
Flash P. 25°F (T.C.C.)
Density 0.747 @60°F
Toxicity: Details unknown. See also Kerosene.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous! Keep away from heat and open flame! Reacts with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

DRYORTH. See Sodium ortho-Silicate.

DULCITOL HEXANITRATE
Synonym: 1,2,3,4,5,6-Hexane hexanitrate.
Description: Crystals.
Formula: $C_6H_8(NO_2)_6$
Constants:
Mol. Wt. 356.2
M. P. Explodes @205°C
Toxicity: Details unknown. See also Nitrates.
Fire Hazard: Dangerous, when exposed to heat or flame or by chemical reaction. A powerful oxidizing agent (Section 6).
Explosion Hazard: Severe, when shocked or exposed to heat (Section 7).
Explosion Point: 205°C
Disaster Control: Highly dangerous; shock and heat will explode it; when heated to decomposition it emits highly toxic fumes of oxides of nitrogen; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

DUMMY CARTRIDGES
Shipping Regulations: Section 11.
Coast Guard Classification: No restrictions.

DUSTS, METALLIC. See specific metal and Powdered Metals.

DUST, TOTAL (BELOW 5% FREE SiO_2)
Toxic Hazard Rating:
Acute Local: Inhalation 1
Acute Systemic: Variable
Chronic Local: Inhalation 1
Chronic Systemic: Variable.
MAC: ACGIH (accepted); 50 millions

of particles per cubic foot of air.

Toxicology: The effects of dust vary according to the composition. If it is organic dust, it is primarily a nuisance, but may produce asthma by being an allergen. If the dust contains toxic compounds, either organic or inorganic, the hazard is that of the toxic component.

Fire and Explosion Hazard: Dangerous; both organic and inorganic dusts can explode or burn violently if exposed to sparks or open flame. See Section 6.

DYNAMAGNITE. See Dynamite.

DYNAMITE

Description: Dynamite is a high explosive used industrially in construction and mining. The name generally refers to a mixture containing as its principal explosive ingredient either glyceryl trinitrate (nitroglycerin) or ammonium nitrate, suitably sensitized. It does not apply to black blasting powders, chlorate powders, and other deflagrating mixtures.

An ordinary blasting cap or an electric blasting cap is used for detonating a charge of dynamite. The various classes and grades of dynamites are made from mixtures composed of an explosive compound or a mixture of explosive compounds, a dope, and a antacid. If any of the explosive ingredients are in a liquid state they are referred to as the "explosive oil," which is usually composed of glyceryl trinitrate (nitroglycerin) and about 25 to 30 percent of ethylene glycol dinitrate. The latter compound depresses the freezing point of the nitroglycerin and renders the dynamite low-freezing. Other compounds may also be used as freezing point depressants. The explosive oil is absorbed by carbonaceous materials that have entirely replaced kieselguhr (diatomaceous earth), formerly used exclusively as the absorbent or dope in dynamites. This type of dope does not enter into the explosive reaction. Wood pulp is now most commonly used as the absorber, either alone or mixed in suitable proportions with flour, starch, etc.

The absorbents may be mixed with an oxidizer such as sodium nitrate, in which case an active dope is formed. For neutralizing any acid that may be present, about 1% of an antacid (calcium carbonate or zinc oxide) is added to the mixture. The explosive oil is mixed into the dope. The strength of a kieselguhr dynamite, when detonated, is derived only from the explosive oil, since kieselguhr is inert. A mixture of this kind is known as a straight dynamite. See Dynamite, Straight. On the other hand, an active dope, (an admixture of carbonaceous absorbents with an oxidizer), furnishes explosive strength in addition to that derived from the explosive ingredients.

By replacing a part of the explosive oil of a straight dynamite with ammonium nitrate, so that the latter becomes the principal explosive ingredient, a mixture known as an ammonia dynamite is obtained. See Dynamite, Ammonia.

When the explosive oil is gelatinized the explosive is known as a gelatin or an ammonia gelatin dynamite. See also Dynamite, Ammonia Gelatin and Dynamite, Gelatin.

Blasting gelatin is a gelatinized mass of an elastic nature obtained by incorporating nitrocotton with an explosive oil into which is mixed about 1% of antacid. See also Dynamite, Blasting Gelatin.

Dynamites may be in bulk form (bag powder) or put up in cartridge form, the most common size being 1 1/4 inches in diameter and 8 inches long, although for holes of small diameter, cartridges as small as 7/8 inch in diameter are also used. In large diameter well-drill holes for quarry blasting, cartridge diameters up to 10 inches, and lengths up to 30 inches may be used. These upper limits or 50 pounds in weight of each cartridge are imposed by the ICC Regulations, and the maximum length of 30 inches applies to all cartridge diameters between 4 and 10 inches.

An integral part of a stick of dynamite is the paraffined paper wrapper that not only holds the ingredients together but enters into the explosive reaction.

The wrapper also affords some measure of protection from moderate exposure to dampness. For blasting in wet operations, a gelatinized dynamite which resists the absorption of water should be used.

The strength of a straight dynamite is graded by its explosive oil content (percentage by weight), while for any other class of dynamite, the strength is determined experimentally in comparison with the various grades of the straight dynamites. For example, a 40% straight dynamite is one which contains 40% of explosive oil; a 40% strength ammonia dynamite, as determined by tests, equals a 40% straight dynamite in strength. In other words a 40% strength ammonia dynamite will release the same energy as an equivalent weight of a 40% straight dynamite.

Toxicity: See Nitrates.

Fire Hazard: See Explosives, High and Nitrates.

Explosion Hazard: While this material is a powerful explosive when detonated by shock or heat, it is only moderately hazardous. See also Explosives, High and Nitrates.

Disaster Control: Dangerous; shock and heat will explode it; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen, and carbon monoxide, etc. It can react vigorously with oxidizing materials.

Storage and Handling: Section 7

Shipping Regulations: See Explosives, High.

DYNAMITE, AMMONIA

Description: This class of dynamite contains ammonium nitrate as the principal explosive ingredient, which may be considered as replacing some of the sodium nitrate and at least 60 percent of the explosive oil as found in the straight dynamites.

A suitable sensitizer must be added because the firing of an ordinary No. 6 blasting cap embedded in pure ammonium nitrate is not capable of bringing about its detonation. If the sensitizer in the dynamite is a liquid ingredient, carbonaceous absorbent materials are added in amounts adequate to avoid leakage of the liquid ingredients and to obtain a suitable oxygen balance. Only a few of the various substances which have been proposed as sensitizers for ammonium nitrate have really been successful. The most successful one takes the form of an explosive oil, like that used in the straight dynamites. Other sensitizers are in solid form and may be either of an explosive nature or a non-explosive nature. Certain of these solid sensitizers are explosive and may be dissolved by the nitroglycerin. Among the solid sensitizers are the organic compounds such as diphenyl and diphenylamine, both of which are non-explosive; or nitrated organic compounds, such as nitrostarch (as used in nitrostarch dynamites), nitrotoluenes, nitronaphthalenes, etc., which are explosive. Inorganic solid substances like calcium silicide, ferrosilicon, aluminum, and sulfur have also been used as sensitizers, although none of them are explosive except when mixed with other substances.

The following is a typical formula for a 40 percent ammonia dynamite: 1% moisture; 15% explosive oil; 31% ammonium nitrate; 38% sodium nitrate; 1% antacid; 4% sulfur; 9% carbonaceous material. For a 1¼ by 8 inch cartridge, the weight of the wrapper per 100 grams of explosive ingredient averages 7 grams.

The ingredients of ammonia dynamites are of a granular nature that have very little cohesion and do not readily resist the absorption of water. Owing to the hygroscopic nature of ammonium nitrate, ammonia dynamites are not usually used in wet holes. Under this condition the gelatinized types of dynamites (ammonia gelatin or gelatin dynamites) should be used and for very wet work it is advisable to use only the gelatin dynamites.

The regular grades of ammonia dynamites range from 15 to 60 percent strength. The ammonia gelatin, or gelatin dynamites of 40 and 60 percent grades are used to greatest extent in blasting operations.

High count powders are modifications of ammonia dynamites. The cartridge count per 50 pound case for the regular grades of ammonia dynamite is about 100 in comparison with

115 to 172 for the high count ammonia dynamites. Those having a cartridge count of 115 have a bulk strength of 60 percent and those of the 172 count have a strength of 20 percent on the same basis. In weight strength all these powders are approximately equivalent to a 60 percent straight dynamite.

Toxicity: See Nitrates.

Fire Hazard: Dangerous; when exposed to heat or flame (Section 6). See also Explosives, High.

Explosion Hazard: Moderate when shocked or exposed to heat or flame (Section 7). See also Explosives, High.

Disaster Control: Highly dangerous; shock and heat will explode it; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen.

Storage and Handling: Section 7

DYNAMITE, AMMONIA GELATIN

Description: An ammonia gelatin dynamite is a gelatinized explosive mixture that contains ammonium nitrate. At least 60 percent of the ammonium nitrate and all of the explosive oil entering into the composition of an ammonia dynamite can be considered as being replaced by a plastic material which then becomes the main explosive ingredient. This material is obtained by gelatinizing about 0.7 percent of a low-nitrated cellulose with an explosive oil which is warmed slightly to produce the jelly-like mass. The other ingredients are then mixed with the gelatinized material. The final product is dense, plastic and more water-resistant than an ammonia dynamite. The regular grades of ammonia gelatin dynamites range from 30 to 90 percent strength.

The following formula is typical of a 40 percent ammonia gelatin: 1% moisture; 26% gelatinized ingredient; 8% ammonium nitrate; 50% sodium nitrate; 1% ant-acid; 6% sulfur; 8% carbonaceous combustible material.

For a 1¼ by 8 inch cartridge the wrapper per 100 grams of explosive ingredient averages 4.5 grams. The cartridge count per 50 pound case averages 100.

When detonated, this class of dynamite emits a low volume of poisonous gases and is therefore recommended along with the gelatin dynamites for underground blastings. On the other hand, quarry gelatin which is a modified type of ammonia gelatin dynamite should be used only in open work and should never be used underground because it emits large volumes of poisonous gases on detonation.

Toxicity: See Nitrates.

DYNAMITE, BLASTING GELATIN

Description: Blasting gelatin, which is the most powerful explosive used industrially, is a translucent material of an elastic texture. It is obtained by incorporating about 7 percent of a low-nitrated cellulose with an explosive oil which is slightly warmed during the process of gelatinization. This explosive is employed only where its high density and water-resisting properties can be advantageously used, such as in submarine work and other operations that are very wet. There is only one grade and it is rated as 100 percent.

Toxicity: See Nitrates.

DYNAMITE, GELATIN

Description: In the gelatin dynamites all the explosive oil contained in a straight dynamite is replaced by a gelatinized material prepared from 0.7 percent of soluble cellulose nitrate. The latter substance is dissolved in the explosive oil to form a jelly-like mass. Wood pulp or other carbonaceous materials, sodium nitrate, and an ant-acid are mixed together to form the dope.

The grades of gelatin dynamites range from 20 to 90 percent, depending on the relative proportions of the gelatinized ingredient and the sodium nitrate.

Gelatin dynamites have a higher density than the ammonia dynamites and are more suitable for blasting in hard ground. They have the further advantage of being plastic and can therefore be packed solidly in the hole so that the explosive is concentrated to best advantage with the least loss of force. Gelatin dynamites are the most suitable dynamites to use in wet holes due to their superior water-resisting properties. On detonation they emit a very low volume of poisonous gases which makes them suitable for use in underground operations where trouble might otherwise be experienced from fumes.

DYNAMITE, SEMI-GELATIN

Description: The principal explosive ingredient of a semi-gelatin dynamite is ammonium nitrate, sensitized by a small quantity of a gelatinized explosive oil. For semi-gelatin dynamite only about 0.3 percent of a soluble nitrocellulose is used for the gelatinization process. Wood pulp and other carbonaceous materials, sodium nitrate, and an ant-acid are also added to the dope.

The two most commonly used grades correspond to a bulk strength of 45 and 60 percent and have cartridge count per 50 pound case of 105 and 120, respectively, for the 1¼ by 8 inch size.

These dynamites are cohesive and are superior in water-resisting properties to the ammonia dynamites. They also emit a smaller volume of poisonous gases. Semi-gelatin dynamites are usually used for blasting rocks and ores of moderate hardness, such as limestones and gypsm.

DYNAMITE, STRAIGHT

Description: A straight dynamite contains no ammonium nitrate, nitroglycerin being the explosive ingredient. Straight dynamites have good water-resisting properties and their mixed ingredients are definitely cohesive. Their present use is confined mainly to propagated ditch blasting and submarine blasting. However, for virtually all other purposes, this class of dynamite has been replaced by the ammonia dynamites and the gelatin types of dynamites. See also Dynamite, Ammonia and Dynamite, Gelatin. On account of the large volume of poisonous gases emitted on detonation the straight dynamites are not recommended for blasting operations in underground workings. For blasting ditches, 50 percent straight dynamite (containing 50 percent explosive oil) has been found to be generally suitable and for other purposes, straight dynamites ranging from 15 to 60 percent can be procured. A typical formula for a 40 percent straight dynamite is as follows: 1% moisture; 40% explosive oil; 44% sodium nitrate; 1% ant-acid; 14% carbonaceous material. The wrapper of straight dynamite constitutes from 5 to 6 percent of the weight of a 1¼ by 8 inch cartridge which weighs nearly one-half pound.

DYPNONE

Description: Liquid.
Formula: $C_6H_5COCH{:}C(CH_3)C_6H_5$
Constants:
  Mol. Wt. 222.27
  M. P. −30°C
  B. P. 246°C @ 50 mm
  Flash P. 350°F (O.C.)
  Density 1.093 @ 20°/20°C
  Vap. Press. < 0.01 @ 20°C
  Vap. D. 7.67
Toxicity: Details unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

DYSPROSIUM

Formula: Dy
Constant:
  At. Wt. 162.46
Toxicity: Unknown
Fire Hazard: Moderate. An active reducing agent.

DYSPROSIUM BROMATE

Description: Yellow, hexagonal needles.
Formula: $Dy(BrO_3)_3 \cdot 9H_2O$
Constants:
  Mol. Wt. 708.35
  M. P. 78°C
  $-6H_2O$ @ 110°C
Toxicity: Details unknown. See Bromates.
Fire Hazard: Moderate, by spontaneous chemical reaction. A powerful oxidizing agent (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes of bromides; can react vigorously

with reducing materials.
Storage and Handling: Section 7

DYSPROSIUM CHROMATE
Description: Yellow crystals.
Formula: $Dy_2(CrO_4)_3 \cdot 10H_2O$
Constants:
Mol. Wt. 853.11
M. P. $-3\frac{1}{2}H_2O$ @150°C
B. P. Decomposes
Toxicity: See Chromium Compounds.
Fire Hazard: Slight, by chemical reaction; an oxidizing agent; can react with reducing materials (Section 6).
Storage and Handling: Section 7

DYSPROSIUM NITRATE
Description: Yellow crystals.
Formula: $Dy(NO_3)_3 \cdot 5H_2O$
Constants:
Mol. Wt. 438.56
Density 88.6
Toxicity: Details unknown. See Nitrates.
Fire Hazard: Moderate, by chemical reaction. A powerful oxidizing agent (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react vigorously with reducing materials.
Storage and Handling: Section 7

DYSPROSIUM OXALATE
Description: Prisms.
Formula: $Dy_2(C_2O_4)_3 \cdot 10H_2O$
Constant: Mol. Wt. 769.14
Toxicity: Toxic. See Oxalates.

DYSPROSIUM SELENATE
Description: Yellow needles.
Formula: $Dy_2(SeO_4)_3 \cdot 8H_2O$
Constants:
Mol. Wt. 897.93
M. P. $-8H_2O$ @200°C
Toxicity: See Selenium and its compounds.
Disaster Control: See Selenium and its compounds.
Storage and Handling: Section 7

E

ECGONINE
Synonym: beta-Oxymethyl-beta-pyridylpropionic acid; tropinecarboxylic acid.
Description: White crystalline alkaloid; slightly bitter taste.
Formula: $C_9H_{15}NO_3 \cdot H_2O$
Constants: Mol. Wt. 203.24
M. P. 205°C
Density 1.370 @12°/4°C
Vap. D. 7.0
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Allergen 1
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen.
Ventilation Control (use moderate rate).
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1

ELECTRIC BLASTING CAPS (1,000 OR LESS). See Explosives, High.
Shipping Regulations: Section 11.
I. C. C. Classification: Explosive C.
Coast Guard Classification: Explosive C.

ELECTRIC BLASTING CAPS (MORE THAN 1,000). See Explosives, High.
Shipping Regulations: Section 11.
I. C. C. Classification: Explosive A - Not accepted.
Coast Guard Classification: Explosive A.

ELECTRIC SQUIBS. See Explosives, High.
Shipping Regulations: Section 11.
I. C. C. Classification: Explosive C.
Coast Guard Classification: Explosive C.

ELECTROLYTE (ACID) BATTERY FLUID. See Sulfuric Acid.
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

EMERY
Synonym: Corundum.
Description: A varicolored mineral.
Formula: Al_2O_3
Constant:
Density 3.95 - 4.10
Toxic Hazard Rating:
Acute Local: Inhalation 1
Acute Systemic: 0
Chronic Local: Inhalation 1
Chronic Systemic: 0
MAC: ACGIH (accepted); 50 million particles per cubic foot of air.

EMETINE
Description: White powder of lumps; bitter taste; darkens on exposure.
Formula: $C_{29}H_{40}O_4N_2$
Constants:
Mol. Wt. 480.63
M. P. 74°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Toxicology: This is one of the two potent alkaloids obtained from the Brazillian plant ipecac. The therapeutic use of various ipecac preparations has given rise to many cases of poisoning, in some instances with fatal results. The toxic effects are particularly prominent if the drug is given intravenously. Special case should therefore be exercised when administering it in this manner. The symptoms of intoxication are gastrointestinal irritation and salivation, as well as general

edema, which follows renal insufficiency, hemoptysis, flaccid paralysis, peripheral neuritis, aphonia, difficulties in swallowing, delirium, coma and failure of the heart. The fatal dose is considered to be approximately 2 grams, whether administered over a short or relatively long period. The drug seems to have a cumulative effect.

Treatment and Antidotes: Since poisoning occurs generally only after repeated dosage, discontinuing use of the drug usually stops the symptoms and recovery follows. When acute intoxication occurs, the remedial measures are purely symptomatic. Heart depression is the most serious symptom and is most to be guarded against.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen.

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

EMPTY CARTRIDGE BAGS, BLACK POWDER IGNITERS. See Explosives, Low.

Shipping Regulations: Section 11.

I. C. C. Classification: Explosive C.

Coast Guard Classification; Explosive C.

EMPTY CARTRIDGE CASES, PRIMED. See Explosives, High.

Shipping Regulations: Section 11.

I. C. C. Classification: Explosive C.

Coast Guard Classification: Explosive C.

ENDO-cis-BICYCLO (2, 2, 1)-5-HEPTENE-2, 3-DICARBOXYLIC ANHYDRIDE

Description: White crystals.

Formula: $C_9H_8O_3$

Constants:

Mol. Wt. 164.2

M. P. 164 - 165°C

Toxicity: Unknown

Fire Hazard: Slight; when heated, it emits acrid fumes; it will react with water or steam to produce heat (Section 6).

Storage and Handling: Section 7

EPHEDRINE

Synonym: 1-Phenyl-2-methylamino propanol.

Description: White granules.

Formula: $C_{10}H_{15}NO$

Constants:

Mol. Wt. 165.23

M. P. 34 - 40°C

B. P. 255°C decomp.

Toxic Hazard Rating:

Acute Local: Allergen 1

Acute Systemic: Ingestion 2; Inhalation 2

Chronic Local: Allergen 1

Chronic Systemic: Ingestion 1; Inhalation 1

Toxicology: Causes rapid pulse, rise in blood pressure, and other actions similar to epinephrine. Has been known to cause allergic sensitization (Section 9).

Fire Hazard: Slight; when heated, it emits toxic fumes (Section 6).

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

EPICHLOROHYDRIN

Synonym: 1-Chloro-2, 3-epoxypropane.

Description: Colorless, mobile liquid; irritating chloroform-like odor.

Formula: C_3H_5OCl

Constants:

Mol. Wt. 92.52

B. P. 117.9°C

Freezing P. −57.1°C

Flash P. 90°F

Density 1.1761 @20°/20°C

Vap. Press. 10 mm @16.6°C

Vap. D. 3.29

Toxic Hazard Rating:

Acute Local: Irritant 3; Ingestion 3; Inhalation 3

Acute Systemic: U

Chronic Local: U

Chronic Systemic: Ingestion 1; Inhalation 1

Fire Hazard: Moderate, when exposed to heat or flame.

To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Disaster Control: Dangerous; when

heated to decomposition, it emits highly toxic fumes of phosgene; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

EPSOM SALTS. See Magnesium Sulfate.

ERADICATOR (PAINT OR GREASE), LIQUID

Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Combustible liquid.
  Coast Guard Classification: Inflammable liquid; red label.

ERBIUM

Description: Dark gray powder.
Formula: Er
Constants: At. Wt. 167.20
  Density 4.77 @15°C
Toxicity: Unknown
Radiation Hazard (Section 5): Artificial isotope Er^{169}, half-life 9.4 days; emits beta particles of 0.33 mev.
Fire Hazard: Moderate, when exposed to heat or flame or by chemical reaction with oxidizers (Section 6).
Explosion Hazard: Moderate, when exposed to flame or spark.

ERBIUM NITRATE

Description: Reddish crystals.
Formula: $Er(NO_3)_3 \cdot 5H_2O$
Constant:
  Mol. Wt. 443.30
Toxicity: See Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

ERBIUM OXALATE

Description: Reddish powder.
Formula: $Er_2(C_2O_4)_3 \cdot 10H_2O$
Constants:
  Mol. Wt. 778.62
  M. P. Decomposes @575°C
Toxicity: See Oxalates.

ERGOTININE

Synonym: Ergotoxine.
Description: White, crystalline alkaloid.
Formula: $C_{35}H_{39}N_5O_5$
Constants:
  Mol. Wt. 609.53
  M. P. 205°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3
  Chronic Local: U
  Chronic Systemic: Ingestion 2
Toxicology: Acute poisoning by ergot is very rare and is caused accidentally, except in some cases where it has been employed to produce abortion. The symptoms are vomiting, burning pains in the abdomen, tingling of the extremities, great thirst, diarrhea, collapse with weak, rapid pulse, cold skin, hemorrhage from the uterus, and abortion. There is ecchymosis in many organs and in the subcutaneous tissues, suppression of urine, prostration, coma and death from respiratory and cardiac failure. Death may occur in a few hours or be delayed a few days. In cases of recovery, abnormal symptoms persist for a few days. Sometimes a cataract forms in the eyes.

Chronic poisoning is very rarely caused by the medicinal use of ergot. Some epidemics have occurred from eating bread made with grain containing ergot. A severe epidemic causing 11,319 cases of poisoning occurred in Russia. Of these, 1,618 were admitted to the hospital and 93 died. There are two types of symptoms from ergot poisoning, one which causes a nervous disorder and one which causes gangrene. In some cases both types have been found, but as a rule one prevails. The gangrenous type generally develops in the fingers and toes; sometimes the entire leg or arm becomes cold and numb, dark, dry, hard and shrunken and falls off with little or no pain and no hemorrhage. Gangrene also occurs in the internal organs. Cataracts are common. The symptoms of spasmodic ergotism are drowsiness, depression, weakness, giddiness, headache, and cramps in the limbs, with itching. In severe cases, convulsions generally clonic and often epileptiform occur. There is mental weakness and sometimes complete dementia. In animals, restlessness, salivation, vomiting and purging, depression, ataxia, clonic convulsions and death by paralysis of the respiratory center occur. The fatal dose cannot be stated accurately. However, 30 grains has caused severe poisoning, but recovery has followed 150 grains (9.72 gm). Gangrene and death have been said to follow 10 grains. Death is more likely to follow prolonged use of small medicinal doses than one large dose.

Treatment and Antidotes: Wash out the stomach with water containing 80 to 100 grains of sodium bicarbonate. Call a physician. Give 0.5 to 1.0 g of sodium tetrathionate dissolved in 10 cc of sterile distilled water intravenously daily. Empty the bowels by soap-suds enemas and purgatives, such as calomel and castor oil. Treat symptomatically. Give stimulants, such as strychnine and coffee. If gangrene sets in, the parts should be bathed with warm water and wrapped in soothing ointment.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

ESTER GUM

Synonym: Rosin ester.

Description: Hard resin.

Constants:
M. P. 285°F
B. P. 495°F
Flash P. 375°F (C.C.)

Toxicity: Unknown

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

Spontaneous Heating: No

To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

ESTERS

Description: A large group of compounds which correspond structurally to salts in inorganic chemistry. They are considered as being derived from acids by the replacement of hydrogen by an organic alkyl radical.

Toxicology: No general statement can be made as to the toxicity of esters. Many of them are highly volatile and hence can act as asphyxiants or narcotics. Skin absorption, as well as inhalation, may be an important route of absorption for those esters which are volatile and have high solvent action. The degree of toxicity of the esters covers a wide range, from slight to high. Esters generally hydrolyze upon contact with moisture; hence a rough guide to the toxicity of a given ester may be the sum of the toxicities of the products of hydrolysis.

ETHANE

Synonyms: Bimethyl; methylmethane; dimethyl; ethyl hydride.

Description: Colorless, odorless gas.

Formula: C_2H_6

Constants: Mol. Wt. 30.07
M. P. −172°C
B. P. −88.6°C
Freezing P. −183.2°C
Density 0.446 @ 0°C (liquid)
Autoign. Temp. 950°F
Vap. D. 1.04

Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Inhalation 2
Chronic Local: 0
Chronic Systemic: Inhalation 1

Fire Hazard: Dangerous, when

exposed to heat or flame; can react vigorously with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide or dry chemical (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range 3.3 - 10.6%
Disaster Control: Dangerous; upon exposure to heat or flame.
Ventilation Control (high rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable gas; red gas label.
Coast Guard Classification: Inflammable gas; red gas label.

ETHANE HEXAMERCARBIDE
Description: Yellowish-white powder.
Formula: $C_2Hg_6O_2(OH)_2$
Constants:
Mol. Wt. 1293.7
M. P. Explodes @230°C
Vap. D. 44.6
Toxicity: See Mercury Compounds, Organic.
Explosion Hazard: Severe, when exposed to heat.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of mercury; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

ETHANETHIOL. See Ethyl Mercaptan.

ETHANOL. See Ethyl Alcohol.

ETHANOLAMINE
Synonym: Monoethanolamine.
Description: Clear somewhat viscous liquid.
Formula: $NH_2CH_2CH_2OH$
Constants:
Mol. Wt. 61.13
M. P. 10.5°C
B. P. 342°F
Flash P. 185°F (C.C.)
Density 1.0179 @20°/20°C
Vap. D. 2.10
Toxicity: Slight. See Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ETHANOL FORMAMIDE
Description: Liquid.
Formula: $HOCH_2CH_2NHCHO$
Constants:
Mol. Wt. 89.09
M. P. −72°C
B. P. 143°C @2.5 mm
Flash P. 165°C
Density 1.17 @25°/4°C
Vap. Press. 0.1 mm @20°C
Vap. D. 3.07
Toxicity: Details unknown; probably slight.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ETHANOL MERCURIC CHLORIDE
Toxicity: See Mercury Compounds, Organic.
Disaster Control: See Mercury Compounds, Organic.
Storage and Handling: Section 7

ETHENE. See Ethylene.

ETHERS
Description: Organic compounds in which an oxygen atom is interposed between two carbon atoms in the structure of the molecule.
Toxicology: The simpler ethers such as ethyl ether, isopropyl ether, etc. are powerful narcotics which in large doses can cause death. The danger from ethers is usually acute and seldom chronic.

There are seldom after-effects to ether intoxication although continued exposure to small concentrations (not enough to cause an overt symptom) has been known to cause loss of appetite, excessive thirst and fatigue.
Fire Hazard: The most common ethers such as ethyl and methyl are particularly dangerous fire hazards. The common ones are

easily ignited and have low flash points. It is necessary to control smoking, open flames or even the use of hot plates in areas where low molecular weight ethers are apt to reach 1% concentration or more in air. Only electrical equipment of explosion-proof type (Group C classification) is permitted to be operated in ether areas. Ethers should not be stored near powerful oxidizers or in areas of high fire hazard. They should be kept cool and the containers electrically grounded to avoid sparks (Section 6).

Explosion Hazard: Dangerous; when heated or exposed to flame or sparks. Besides the risk of explosion from air mixtures of ether vapors, ethers tend to form peroxides upon standing. When ethers containing peroxides are heated they can detonate. See also Ethyl Ether.

Disaster Control: Dangerous; shock or heat can cause gaseous ethers to escape from their containers; they can react vigorously with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Storage and Handling: Section 7

Shipping Regulations: Section 11.
Coast Guard Classification: Inflammable liquid; red label.

6-ETHOXY-1,2-DIHYDRO-2,2,4-TRIMETHYL QUINOLINE

Description: Clear, light yellow liquid.
Formula: $C_{14}H_{19}NO$
Constants: Mol. Wt. 217.3
M. P. < 0°C
B. P. 125°C @2 mm
Vap. D. 7.48
Density 1.030 @25°C
Fire Hazard: Slight; when heated to decomposition, it emits toxic fumes; can react with oxidizing materials.
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-ETHOXYMETHYL-2,4-DIMETHYL PENTANEDIOL-1,5

Description: Liquid.
Formula: $HOCH_2CH(CH_3)CH_2C(CH_3)(CH_2OCH_3)CH_2OH$
Constants:
Mol. Wt. 176.25
M. P. -40°C
B. P. 208°C @100 mm
Flash P. 295°F (O.C.)
Density 1.0165
Vap. D. 6.08
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

3-ETHOXYPROPIONALDEHYDE

Description: Liquid.
Formula: $C_2H_5OCH_2CH_2CHO$
Constants:
Mol. Wt. 102.13
M. P. -69.4°C
B. P. 135.2°C
Flash P. 100°F (O.C.)
Density 0.918 @20°/20°C
Vap. D. 3.63
Vap. Press. 5.5 mm @20°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

3-ETHOXYPROPIONIC ACID

Description: Liquid.
Formula: $C_2H_5OCH_2CH_2COOH$
Constants:
Mol. Wt. 118.13
M. P. -10.7°C
B. P. 219°C
Flash P. 225°F (O.C.)
Density 1.0474
Vap. D. 4.08
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon

dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ETHOXYTRIGLYCOL
Formula: $C_2H_5O(C_2H_4O)_3H$
Constants:
Mol. Wt. 178.21
B. P. 255.4°C
Flash P. 275°F (C.C.)
Density 1.0208 @20°/20°C
Vap. Press. 0.01 mm @20°C
Toxicity: See Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

ETHOXYTRIMETHYLSILANE
Formula: $C_5H_{14}OSi$
Constants:
Mol. Wt. 118.3
B. P. 75.7°C
Vap. Press. 100 mm @22.1°C
Vap. D. 4.1
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate; when heated, it can ignite; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ETHYL ABIETATE
Synonym: Abietic acid, ethyl ester.
Description: Amber-colored, viscous liquid.
Formula: $C_{19}H_{29}CO_2C_2H_5$
Constants:
Mol. Wt. 302.44
M. P. 45°C
B. P. 350°C
Flash P. 352.4°F
Density 1.02
Vap. D. 11.4
Toxicity: See Abietic Acid and Ethyl Alcohol.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ETHYL ACETAMIDE
Description: Water-white liquid.
Formula: $CH_3CONHC_2H_5$
Constants:
Mol. Wt. 87.1
M. P. -32°C
B. P. 206 - 208°C
Flash P. 230°F
Density 0.920 @20°/20°C
Vap. D. 3.0
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

ETHYL ACETANILIDE
Synonym: Ethyl phenyl acetamide.
Description: White crystals; faint odor.
Formula: $CH_3CON(C_2H_5)(C_6H_5)$
Constants:
Mol. Wt. 163.21
M. P. 54°C
B. P. 258°C
Flash P. 255°F
Density 0.994
Vap. D. 5.62
Toxicity: Details unknown. See also Acetanilide.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ETHYL ACETATE
Synonym: Acetic ether; ethyl ester; ethyl ethanoate.
Description: Colorless liquid; fragrant odor.
Formula: $CH_3COOC_2H_5$
Constants:
Mol. Wt. 88.10
M. P -83.6°C
B. P. 77.15°C
Flash P. 40°F (T.O.C.)
Density 0.8946 @25°C
Autoign. Temp. 900°F

Vap. Press. 100 mm @27.0°C
Vap. D. 3.04
Toxic Hazard Rating:
Acute Local: Irritant 1;
Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Chronic Local: Irritant 1
Chronic Systemic: Ingestion 1; Inhalation 1; Skin Absorption 1
MAC: ACGIH (accepted); 400 parts per million in air; 1440 milligrams per cubic meter of air.
Toxicology; Ethyl acetate is irritating to mucous surfaces, particularly the eyes, gums, and respiratory passages and is also mildly narcotic. On repeated or prolonged exposures, it causes conjunctival irritation and corneal clouding. It can cause dermatitis. High concentrations have a narcotic effect and can cause congestion of the liver and kidneys. Chronic poisoning has been described as producing secondary anemia, leucocytosis and cloudy swelling, and fatty degeneration of the viscera.
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
Spontaneous Heating: No
Underwriters Laboratory Classification: 85-90
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range 2.2 - 11.5%
Disaster Control: Dangerous, upon exposure to heat or flame.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11
I.C.C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.
MCA warning label.

ETHYL ACETOACETATE

Synonym: Diacetic ether; acetoacetic ester.
Description: Colorless liquid; fruity odor.
Formula: $CH_3COCH_2COOC_2H_5$
Constants:
Mol. Wt. 130.14
B. P. 180.8°C
Freezing P. -45°C
Flash P. 185°F (C.O.C.)
Density 1.0261 @20°/20°C
Vap. Press. 1 mm @28.5°C
Vap. D. 4.48
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ETHYL ACRYLATE

Synonym: Ethyl propenoate.
Description: Colorless liquid.
Formula: $CH_2CHCOOC_2H_5$
Constants:
Mol. Wt. 100.11
B. P. 99.8°C
Freezing P. < -72°C
Flash P. 60°F (O.C.)
Density 0.924 @20°/4°C
Vap. Press. 29.3 mm @20°C
Vap. D. 3.45
Toxic Hazard Rating:
Acute Local: Irritant 3
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: U
Toxicology: Oral administration of 0.42 g or more per kg of body weight in the case of rabbits resulted in fatal poisoning. This was characterized in its terminal stages by dyspnea, cyanosis, and convulsive movements. It caused severe local irritation of the gastro-enteric tract; and toxic

degenerative changes of cardiac, hepatic, renal, and splenic tissues were observed. It gave no evidence of cumulative effects in rabbits. When applied to the intact skin of rabbits, the ethyl ester caused marked local irritation, erythema, edema, thickening, and vascular damage. Animals subjected to a fairly high concentration of these esters suffered irritation of the mucous membranes of the eyes, nose, and mouth as well as lethargy, dyspnea, and convulsive movements.

Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Unknown

Disaster Control: Dangerous, upon exposure to heat or flame.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

ETHYL ALCOHOL

Synonyms: Ethanol; methyl carbinol; spirit of wine.

Description: Clear, colorless, fragrant liquid.

Formula: CH_3CH_2OH

Constants:

Mol. Wt. 46.07

B. P. 78.32°C

Freezing P. −114.1°C

Flash P. 61°F (C.O.C.)

Density 0.7893 @ 20°/4°C

Autoign. Temp. 700 - 800°F

Vap. Press. 40 mm @ 19°C

Vap. D. 1.59

Toxic Hazard Rating:

Acute Local: Irritant 1

Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 1

Chronic Local: Irritant 1

Chronic Systemic: Ingestion 1; Inhalation 1; Skin Absorption 1

MAC: ACGIH (accepted); 1000 parts per million in air; 1880 milligrams per cubic meter of air.

Toxicology: The systemic effect of ethyl alcohol differs from that of methyl alcohol. Ethyl alcohol is rapidly oxidized in the body to carbon dioxide and water, and in contrast to methyl alcohol, no cumulative effect occurs. Though ethyl alcohol possesses narcotic properties, concentrations sufficient to produce this effect are not reached in industry. Exposure to concentrations of 5,000 to 10,000 ppm result in irritation of the eyes and mucous membranes of the upper respiratory tract. If continued for an hour, stupor and drowsiness may result. Concentrations below 1,000 ppm usually produce no signs of intoxication. There is no concrete evidence that repeated exposure to ethyl alcohol vapor results in cirrhosis of the liver. The main effect of ethyl alcohol is due to its irritant action on the mucous membranes of the eyes and upper respiratory tract.

Exposure to concentrations of over 1,000 ppm may cause headache, irritation of the eyes, nose and throat, and, if long continued, drowsiness and lassitude, loss of appetite and inability to concentrate.

Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.

Disaster Control: Dangerous, when exposed to heat or flame.

Spontaneous Heating: No

Underwriters' Laboratory Classification: 70

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Moderate, when exposed to flame.

Explosive Range: 3.28 - 19%.

Ventilation Control (use moderate rate): Section 2

Storage and Handling: Section 7

Shipping Regulations: Section 11.

I. C. C. Classification: Flammable liquid; red label.

Coast Guard Classification: Inflammable liquid; red label.

ETHYL alpha-ALLYL ACETOACETATE

Description: Liquid

Formula:

$CH_3COCH(CH_2CHCH_2)CO_2C_2H_5$

Constants:
Mol. Wt. 170.23
B. P. 208 - 218°C
Density 0.989 @25°/20°C
Vap. D. 5.88

Toxicity: Details unknown. See also Esters.

Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials (Section 6).

Storage and Handling: Section 7

ETHYLAMINE

Synonyms: Aminoethane; monoethylamine.

Description: Colorless liquid; strong ammoniacal odor.

Formula: $C_2H_5NH_2$

Constants:
Mol. Wt. 45.08
M. P. -80.6°C
B. P. 16.6°C
Flash P. Below 0°F
Density 0.7059 @0°/4°C
Autoign. Temp. 723°F
Vap. Press. 400 mm @2.0°C
Vap. D. 1.56

Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U

MAC: ACGIH (accepted); 25 parts per million in air; 46 milligrams per cubic meter of air.

Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Disaster Control: Dangerous; keep away from heat and open flame!

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

N-ETHYLANILINE

Synonym: Ethyl phenyl amine.

Description: Clear, yellow-brown oil.

Formula: $C_2H_5NH(C_6H_5)$

Constants:
Mol. Wt. 121.2
M. P. -63.5°C
B. P. 204°C
Density 0.958 @25°/25°C
Vap. Press. 1 mm @38.5°C
Vap. D. 4.18

Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: Allergen 1
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption

Fire Hazard: Unknown

Disaster Control: Highly dangerous; on decompositon or on contact with acid or acid fumes, it emits highly toxic fumes of aniline and oxides of nitrogen; can react with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

o-ETHYLANILINE

Description: Yellow liquid; darkens upon standing.

Formula: $C_6H_4NH_2C_2H_5$

Constants:
Mol. Wt. 121.2
M. P. -63.5°C
B. P. 215°C
Flash P. 185°F (O.C.)
Density 0.98 @25°/25°C
Vap. D. 4.17

Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: Allergen 1
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3

Fire Hazard: Moderate, when exposed to heat or flame.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of aniline and oxides of nitrogen; can react with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1
Storage and Handling: Section 7

ETHYL ARSENIOUS OXIDE

Description: Colorless oil; garlic-like odor.
Formula: C_2H_5AsO
Constants:
  Mol. Wt. 120.0
  B. P. 158°C @10 mm
  Density 1.802 @11°C
  Vap. D. 4.14
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

ETHYLBENZENE

Synonyms: Ethylbenzol; phenylethane.
Description: Colorless liquid; aromatic odor.
Formula: $C_6H_5C_2H_5$
Constants:
  Mol. Wt. 106.16
  B. P. 136.2°C
  Freezing P. −94.9°C
  Flash P. 85°F (O.C.)
  Density 0.8669 @20°/4°C
  Autoign. Temp. 870°F
  Vap. Press. 10 mm @25.9°C
  Vap. D. 3.66
Toxic Hazard Rating:
  Acute Local: Irritant 2
  Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
  Chronic Local: U
  Chronic Systemic: U
MAC: ACGIH (accepted); 200 parts per million in air; 868 milligrams per cubic meter of air.
Toxicology: The liquid is an irritant to the skin and mucous membranes. A concentration of 0.1% of the vapor in air is an irritant to the eyes of humans, and a concentration of 0.2% is extremely irritating at first, then causes dizziness, irritation of the nose and throat and a sense of constriction of the chest. Exposure of guinea pigs to 1% concentrations has been reported as causing ataxia, loss of consciousness, tremor of the extremities and finally death through respiratory failure. The pathological findings were congestion of the brain and lungs, with edema. No data are available regarding the effect of chronic exposure.

Erythema and inflammation of the skin may result from contact of the skin with the liquid (Section 9). Exposure to the vapor causes lachrymation and irritation of the nose and throat, dizziness, and a sense of constriction of the chest. The irritant properties are sufficient to cause workers to leave an atmosphere containing 0.5% of the vapor.
Fire Hazard: Moderate, when exposed to heat or flame; can react vigorously with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; keep away from heat and open flame!
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  Coast Guard Classification: Combustible liquid.

ETHYL BENZOATE

Synonym: Benzoic ether.
Description: Colorless, aromatic liquid.
Formula: $C_6H_5CO_2C_2H_5$
Constants:
  Mol. Wt. 150.2
  M. P. −34.6°C
  B. P. 213.4°C
  Flash P. 200°F (O.C.)
  Density 1.048 @20°/20°C
  Vap. Press. 1 mm @44.0°C
  Vap. D. 5.17
Toxicity: See Ethyl Alcohol and Benzoic Acid.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ETHYL BENZOYL ACETATE

Description: Clear liquid.

Formula: $C_6H_5COCH_2COOC_2H_5$
Constants:
Mol. Wt. 192.21
B. P. 265.0°C Decomposes
Flash P. 285°F (O. C.)
Density 1.11
Vap. Press. 1 mm @107.6°C
Vap. D. 6.63
Toxicity: Details unknown.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ETHYL BENZYL ANILINE

Description: Clear, colorless oil.
Formula: $C_6H_5N(C_2H_5)CH_2C_6H_5$
Constants:
Mol. Wt. 211.3
B. P. 286°C
Density 1.034
Vap. D. 7.28
Toxicity: Details unknown. See also Aniline.
Fire Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of aniline and oxides of nitrogen; can react with oxidizing materials.
Storage and Handling: Section 7

ETHYL BORATE

Synonyms: Triethyl borate; triethoxyboron.
Description: Colorless liquid; mild odor.
Formula: $B(OC_2H_5)_3$
Constants:
Mol. Wt. 146.00
B. P. 120°C
Flash P. 52°F (C. C.)
Density 0.864 @26.5°C
Vap. D. 5.04
Toxicity: Details unknown. See also Boron Compounds.
Fire Hazard: Dangerous, when exposed to heat or flame; will react with water or steam to produce flammable vapors; can react vigorously with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; keep away from heat and open flame!
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.

ETHYL BROMIDE

Synonyms: Bromoethane; hydrobromic ether; bromic ether.
Description: Colorless, volatile liquid.
Formula: CH_3CH_2Br
Constants: Mol. Wt. 108.98
M. P. −119°C
B. P. 38.4°C
Freezing P. −119.0°C
Flash P. None
Density 1.430 @20°/4°C
Autoign. Temp. 952°F
Vap. Press. 400 mm @21°C
Vap. D. 3.76
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
MAC: ACGIH (accepted); 200 parts per million in air; 892 milligrams per cubic meter of air.
Toxicology: It readily decomposes into volatile toxic products, such as hydrobromic acid and bromine, particularly in the presence of hot surfaces or open flame. Physiologically, it is an anesthetic and narcotic. Its vapors are markedly irritating to the lungs when inhaled for even short periods. It can produce acute congestion and edema. It is much less toxic than methyl bromide, but more toxic than ethyl chloride.
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 6.0 - 11.0%
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromine; will react with water or steam to

produce toxic and corrosive fumes; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

ETHYL BROMOACETATE

Synonym: Ethyl bromoethanoate.
Description: Colorless to straw-colored liquid.
Formula: $CH_2BrCOOC_2H_5$
Constants:
Mol. Wt. 167.01
B. P. 158.8°C
Freezing P. <-20°C
Flash P. None
Density 1.514 @13°/4°C
Vap. D. 5.8
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of bromides; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

2-ETHYL BUTANOL

Synonyms: 2-Ethyl butyl alcohol.
Description: Clear liquid.
Formula: $(C_2H_5)_2CHCH_2OH$
Constants:
Mol. Wt. 102.17
B. P. 148.9°C
Flash P. 135°F (C.O.C.)
Density 0.8328
Vap. Press. 0.9 mm @20°C
Vap. D. 3.4
Toxicity: See Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-ETHYL BUTYLACETATE

Description: Colorless liquid; mild odor.
Formula: $(C_2H_5)_2CHCH_2OOCCH_3$
Constants:
Mol. Wt. 144.21
B. P. 324°F
Flash P. 130°F (O.C.)
Density 0.875-0.881 @20°/20°C
Vap. D. 5.0
Toxicity: Unknown. See Esters.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11. Coast Guard Classification: Combustible liquid.

2-ETHYL BUTYL ACRYLATE

Description: Clear, colorless liquid.
Formula: $H_2C{=}CHCOOCH_2C(C_2H_5)HC_2H_5$
Constants:
Mol. Wt. 156.22
B. P. 82°C @10 mm
Freezing P. -70°C
Flash P. 125°F (O.C.)
Density 0.8964 @20°/20°C
Vap. Press. 1.7 mm @20°C
Toxicity: Details unknown; a powerful irritant.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

ETHYL BUTYL ALCOHOL. See Amyl Carbinol.

ETHYL n-BUTYLAMINE

Description: Water-white liquid.

Formula: $C_2H_5NHCH_2CH_2CH_2CH_3$
Constants:
Mol. Wt. 101.2
B. P. 110 - 113°C
Flash P. 65°F
Density 0.739 @20°/20°C
Vap. D. 3.5
Toxicity: Details unknown. See also Amines.
Fire Hazard: Dangerous; when exposed to heat or flame; can react vigorously with oxidizing materials (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; keep away from heat and open flame!
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

2-ETHYL BUTYL CARBONATE

Description: Liquid.
Formula: $(C_2H_5)(C_4H_9)CO_3$
Constants:
Mol. Wt. 146.48
B. P. 275°F
Flash P. 122°F (C.C.)
Density 0.92
Vap. D. 5.03
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

2-ETHYLBUTYL "CELLOSOLVE"

Synonym: 2,2-Ethyl butoxy ethanol.
Description: Liquid.
Formula: $(C_2H_5)_2CHCH_2OC_2H_4OH$
Constants:
Mol. Wt. 146.2
B. P. 197°C
Freezing P. −90°C
Flash P. 180°F (O.C.)
Density 0.8954 @20°/20°C
Vap. Press. 0.17 mm @20°C
Vap. D. 5.04
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ETHYL-n-BUTYL ETHER

Synonym: Butyl ethyl ether.
Description: Liquid.
Formula: $C_2H_5OC_4H_9$
Constants:
Mol. Wt. 102.2
B. P. 92°C
M. P. −124°C
Flash P. 30°F
Density 0.7528 @20°/20°C
Vap. D. 3.52
Toxicity: Details unknown. See also Ethers.
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Details unknown. See also Ethers.
Disaster Control: Dangerous; keep away from heat and open flame!
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

ETHYL BUTYL KETONE

Description: Clear liquid.
Formula: $(C_2H_5)(C_4H_9)CO$
Constants:
Mol. Wt. 114.2
M. P. −36.7°C
B. P. 148°C
Flash P. 115°F (O.C.)
Density 0.8197 @20°/20°C
Vap. D. 3.93
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-ETHYL-2-BUTYL-1,3-PROPANEDIOL

Description: Crystals or liquid.
Formula: $HOCH_2C(C_2H_5)(C_4H_9)CH_2OH$
Constants:
Mol. Wt. 160.25
B. P. 178°C @50 mm
Freezing P. 40.1°C
Flash P. 280°F (O.C.)
Density 0.931 @50°/20°C
Vap. Press. <0.01 mm @20°C
Vap. D. 5.53
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2-ETHYL BUTYL TITANATE

Synonym: Hexyl titanate.
Description: A liquid.
Formula: $Ti[OCH_2CH(C_2H_5)_2]_4$
Constants:
Mol. Wt. 453
M. P. -55°C
B. P. 208°C @10 mm
Density 0.96
Toxicity: See Hexanol.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

2-ETHYL BUTYRALDEHYDE

Synonyms: 2-Ethylbutyric aldehyde, diethyl acetaldehyde.
Description: Colorless.
Formula: $(C_2H_5)_2CHCHO$
Constants:
Mol. Wt. 100.16
B. P. 116.8°C
Flash P. 70°F (O.C.)
Freezing P. -89°C
Density 0.8164 @20°/20°C
Vap. Press. 13.7 mm @20°C
Vap. D. 3.45
Toxicity: Details unknown. See also Aldehydes.
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous, keep away from heat and open flame!
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

ETHYL n-BUTYRATE

Synonyms: Butyric ether, ethyl butanoate.
Description: Colorless, volatile liquid; pineapple-like odor.
Formula: $C_3H_7CO_2C_2H_5$
Constants: Mol. Wt. 116.16
M. P. -93.3°C
B. P. 121.0°C
Flash P. 78°F (C.C.)
Density 0.8788
Vap. Press. 10 mm @15.3°C
Vap. D. 4.0
Autoign. Temp. 865°F
Toxicity: Details unknown. See Ethyl Alcohol and Butyric Acid.
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; keep away from heat and open flame!
Ventilation Control (use normal rate Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Combustible liquid.

2-ETHYL BUTYRIC ACID

Synonyms: 2-Ethyl butanoic acid, diethyl acetic acid.
Description: Water-white liquid.
Formula: $(C_2H_5)_2CHCOOH$
Constants: Mol. Wt. 116.16
M. P. -15°C
B. P. 193.4°C
Flash P. 210°F (C.O.C.)
Freezing P. -9.4°C
Density 0.9225 @20°/20°C
Vap. Press. 0.06 mm @20°C
Vap. D. 4.01
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ETHYL CAPRATE
Synonyms: Capric ether; caprinic ether.
Description: Colorless, fragrant liquid.
Formula: $C_9H_{19}CO_2C_2H_5$
Constants:
  Mol. Wt. 200.3
  B. P. 243°C
  Density 0.862
  Vap. D. 6.9
Toxicity: See Ethyl Alcohol.
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials.
Storage and Handling: Section 7

ETHYL CARBAMATE
Synonym: Urethane; ethyl urethane.
Description: Colorless, odorless crystals.
Formula: $CO(NH_2)OC_2H_5$
Constants: Mol. Wt. 89.1
  M. P. 49°C
  B. P. 184°C
  Density 0.9862
  Vap. Press. 10 mm @77.8°C
  Vap. D. 3.07
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2
  Chronic Local: U
  Chronic Systemic: U
Toxicology: Large doses produce narcosis and may be followed by degenerative changes in the liver.
Fire Hazard: Slight; when heated, it emits toxic fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

ETHYL CELLULOSE
Description: White, granular solid.
Formula: Variable.
Constant: M. P. 240+°C
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame or by chemical reaction with oxidizing agents. Flammability varies with degree of replacement of OH^- radicals of cellulose by ethyl radical (Section 6).
Storage and Handling: Section 7

ETHYL CHLORIDE
Synonyms: Chloroethane; hydrochloric ether; muriatic ether.
Description: Colorless liquid or gas; ether-like odor, burning taste.
Formula: CH_3CH_2Cl
Constants:
  Mol. Wt. 64.52
  B. P. 12.3°C
  Freezing P. −139°C
  Flash P. −58°F (C.C.)
  Density 0.9214 @0°/4°C
  Autoign. Temp. 966°F
  Vap. Press. 1000 mm @20°C
  Vap. D. 2.22
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 2; Inhalation 2
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: U
MAC: ACGIH (accepted); 1000 parts per million in air; 2660 milligrams per cubic meter of air.
Toxicology: The liquid is harmful to the eyes and can cause some irritation. In the case of guinea pigs, the symptoms attending exposure are similar to those caused by methyl chloride, except that the signs of lung irritation are not as pronounced. It gives some warning of its presence because it is irritating, but it is possible to tolerate exposure to it until one becomes unconscious. It is the least toxic of all of the chlorinated hydrocarbons. It can cause narcosis, although the effects are usually transient. Animal experiments show some evidence of kidney irritation and accumulation of fat due to this material in the kidneys, cardiac muscles and liver.
Fire Hazard: Highly dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Severe, when exposed to flame.
Explosive Range: 3.6 - 12.0%
Disaster Control: Highly dangerous! Keep away from heat and open flame; forms phosgene on combustion; reacts with water or steam to produce toxic and corrosive fumes; can react vigorously with oxidizing materials.
Ventilation Control (use high

rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.
MCA warning label

ETHYL CHLOROACETATE

Synonym: Ethyl chloroethanoate.
Description: Colorless liquid; fruity odor.
Formula: $CH_2ClCOOC_2H_5$
Constants:
Mol. Wt. 122.55
B. P. 143.6°C
Freezing P. −26.6°C
Flash P. 150°F
Density 1.159 @20°/4°C
Vap. Press. 10 mm @37.5°C
Vap. D. 4.3
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Combustible liquid.

ETHYL CHLOROACETOL

Description: Water-white liquid; pleasant odor.
Formula: $ClCH_2CH(OC_2H_5)_2$
Constants:
Mol. Wt. 156.6
M. P. −32°C
B. P. 151°C
Flash P. 117°F
Density 1.022 @20°C
Vap. D. 5.41
Toxicity: Details unknown
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

ETHYL CHLOROCARBONATE

Synonyms: Ethyl chloromethanoate; ethyl chloroformate.
Description: Colorless liquid.
Formula: $ClCOOC_2H_5$
Constants:
Mol. Wt. 108.53
M. P. −80.6°C
B. P. 94°C
Flash P. 61°F (C. C.)
Density 1.138 @20°/4°C
Vap. D. 3.74
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous; when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

ETHYL CHLOROFORMATE. See Ethyl Chlorocarbonate.

ETHYL CHLOROSULFONATE

Description: Colorless oily liquid; pungent odor.
Formula: $C_2H_5ClSO_3$
Constants:
  Mol. Wt. 144.57
  B. P. 152 - 153°C
  Density 1.379 @0°C
  Vap. D. 5.0
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated, it emits highly toxic fumes of phosgene; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ETHYL CROTONATE

Synonym: 2-Pentene-3-carboxylic acid.
Description: Colorless, monoclinic prisms, or water-white liquid; pungent odor.
Formula: $CH_3CHCHCOOC_2H_5$
Constants:
  Mol. Wt. 114.14
  M. P. 45°C (solid)
  B. P. 209°C (solid); 139.0°C (liquid)
  Flash P. 36.0°F
  Density 0.9207 @20°/20°C
  Vap. D. 3.93
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous, upon exposure to heat or flame.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ETHYL CYANIDE

Synonyms: Propionitrile; propanenitrile.
Description: Colorless liquid; ethereal odor.
Formula: CH_3CH_2CN
Constants:
  Mol. Wt. 55.08
  M P. -103.5°C
  B. P. 97.1°C
  Density 0.783 @21°/4°C
  Vap. D. 1.9
Toxicity: Highly toxic. See Cyanides.
Fire Hazard: See Cyanides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides; will react with water or steam to produce toxic and flammable vapors.
Storage and Handling: Section 7

ETHYL CYANOACETATE

Synonym: Malonic ethyl ester nitrile.
Description: Colorless to pale straw-colored liquid.
Formula: $CNCH_2CO_2C_2H_5$
Constants:
  Mol. Wt. 113.1
  M. P. -22.5°C
  B. P. 206°C
  Flash P. 230°F
  Density 1.06 @25°/25°C
  Vap. Press. 1 mm @67.8°C
  Vap. D. 3.9
Toxicity: Highly toxic. See Cyanides.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides; will react with water or steam to produce toxic and flammable vapors; it can react with

oxidizing materials.
Storage and Handling: Section 7

ETHYLDICHLOROARSINE

Synonym: Dichloroethylarsine.
Description: Colorless liquid; fruity, biting, irritating odor.
Formula: $C_2H_5AsCl_2$
Constants:
Mol. Wt. 174.89
M. P. −65°C
B. P. 156°C Decomposes
Freezing P. −28.3°C
Density 1.742 @14°C
Vap. Press. 2.29 mm @21.5°C
Vap. D. 6.03
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: Dangerous; on contact with acid or acid fumes, it emits highly toxic fumes of arsenic and phosgene; will react with water or steam to produce toxic and corrosive fumes; can react with oxidizing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison A; poison gas label.
Coast Guard Classification: Poison A; poison gas label.

ETHYLDICHLOROSILANE

Description: Liquid.
Formula: $C_2H_5SiHCl_2$
Constants:
Mol. Wt. 129.1
Vap. D. 4.45
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated, it emits highly toxic fumes of phosgene; will react with water or steam to produce heat, toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ETHYL DIETHANOLAMINE

Description: White, clear liquid.
Formula: $C_2H_5N(C_2H_4OH)_2$
Constants:
Mol. Wt. 133.19
B. P. 464°F
Flash P. 255°F (O. C.)
Density 1.015 @20°C
Vap. D. 4.59
Toxicity: Details unknown. See also Amines.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes of nitrogen oxides.
Storage and Handling: Section 7

ETHYL DIMETHYLCHLOROSILANE

Description: Liquid.
Formula: $C_2H_5(CH_3)_2SiCl$
Constants:
Mol. Wt. 122.7
B. P. 89.2°C
Vap. D. 4.24
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated, it emits highly toxic fumes of phosgene; will react with water or steam to produce heat and toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ETHYL DIPHENYL ETHER

Description: Light green to yellow liquid; aromatic odor.
Formula: $C_6H_5OC_6H_4C_2H_5$
Constants:
Mol. Wt. 198.3
M. P. < −20°C
Flash P. 295°F
Density 1.032 @25°/25°C
Vap. D. 6.84
Toxicity: Details unknown. See also Ethers.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Slight, by chemical reaction with oxidizing agents.
Storage and Handling: Section 7

ETHYL DIPHENYL PHOSPHINE

Description: Liquid.
Formula: $(C_6H_5)_2PC_2H_5$
Constants:
  Mol. Wt. 214.2
  B. P. 293°C
  Vap. D. 7.39
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: Ingestion 3; Inhalation 3
Fire Hazard: Unknown
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated, it emits highly toxic fumes of phosphine and oxides of phosphorus; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ETHYLENE

Synonyms: Ethene; elayl; etherin.
Description: Colorless gas; sweet odor and taste.
Formula: CH_2CH_2
Constants:
  Mol. Wt. 28.05
  M. P. −169.4°C
  B. P. −103.9°C
  Density 0.610 @0°C
  Autoign. Temp. 1009°F
  Vap. D. 0.98
Toxic Hazard Rating:
  Acute Local: 0
  Acute Systemic: Inhalation 2
  Chronic Local: 0
  Chronic Systemic: 0
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or fine water spray (Section 6).
Explosion Hazard: Moderate, when exposed to flame; shock can shatter its compressed gas container with explosive force.
Explosive Range: 3.02 -34%
Disaster Control: Dangerous; flammable gas!
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable gas; red gas label.
  Coast Guard Classification: Inflammable gas; red gas label.

ETHYLENE BIS-DITHIOCARBAMATE DERIVATIVE

Toxicity: Details unknown, but probably toxic; a fungicide.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

ETHYLENE BIS-(GLYCOLIC ACID)

Description: Light-colored, viscous liquid.
Formula: $(CH_2OCH_2COOH)_2$
Constants:
  Mol. Wt. 178.14
  M. P. 30 - 35°C
  Density 1.3 @75°/25°C
  Vap. D. 6.14
Toxicity: Unknown
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

ETHYLENE BROMIDE. See Ethylene Dibromide.

ETHYLENE CARBONATE

Synonyms: Glycol carbonate; dioxolone-2.
Description: Colorless liquid or crystalline solid.
Formula: $\underline{OCH_2CH_2OCO}$
Constants:
  Mol. Wt. 88.06
  B. P. 244°C @740mm
  Freezing P. 35.7°C
  Flash P. 290°F (O.C.)
  Density 1.322 @40°/20°C
  Vap. Press. 0.01 mm @20°C
  Vap. D. 3.04
Toxicity: Details unknown, but probably low as ordinarily used.
Fire Hazard: Slight, when exposed to heat or flame; can react

with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ETHYLENE CHLOROBROMIDE

Synonym: 1-Bromo-2-chloroethane.
Description: Colorless, volatile liquid; sweet chloroform-like odor.
Formula: $BrCH_2CH_2Cl$
Constants:
Mol. Wt. 143.4
B. P. 106.1°C
Freezing P. −18.4°C
Flash P. None
Density 1.7273 @25°/4°C
Vap. Press. 40 mm @29.7°C
Vap. D. 4.94
Toxicity: Details unknown. There is some degree of toxicity.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and bromides.
Storage and Handling: Section 7

ETHYLENE CHLOROHYDRIN

Synonyms: β-Chloroethyl alcohol; glycol chlorohydrin.
Description: Colorless liquid; faint ethereal odor.
Formula: CH_2ClCH_2OH
Constants:
Mol. Wt. 80.52
M. P. −69°C
B. P. 128.8°C
Flash P. 140°F (O.C.)
Density 1.213 @20°/4°C
Autoign. Temp. 797°F
Vap. Press. 10 mm @30.3°C
Vap. D. 2.78
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (accepted); 5 parts per million in air; 16 milligrams per cubic meter of air.
Toxicology: Ethylene chlorohydrin is a narcotic poison affecting the nervous system and the liver, spleen and lungs. Exposure to the vapor may result in irritation of the mucous membranes, followed by sleepiness, drowsiness, giddiness, nausea and vomiting. The initial symptoms may be slight. After a latent period of several hours, dyspnea, severe headache, stupor, cyanosis and pain over the heart may develop. Autopsy shows pulmonary edema, ulceration of the mucous membranes of the larger bronchi, and acute liver and kidney lesions. Fatal amounts of ethylene chlorohydrin may be absorbed through the skin.
Fire Hazard: Moderate, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene; will react with water or steam to produce toxic and corrosive fumes; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
MCA warning label

ETHYLENE CYANIDE. See Succinontrile.

ETHYLENE CYANOHYDRIN

Synonyms: β-Hydroxypropionitrile; hydracrylonitrile; glycol cyanohydrin.
Description: Colorless to straw-colored liquid.
Formula: $HOCH_2CH_2CN$
Constants:
Mol. Wt. 71.08
B. P. 228°C Decomposes
Freezing P. −46°C
Flash P. < 80°F
Density 1.0404 @25°C
Vap. Press. 0.08 mm @25°C
Vap. D. 2.45
Toxicity: See Cyanides.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when

heated or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides; will react with water or steam to produce toxic and flammable vapors; can react vigorously with oxidizing materials.
Ventilation Controls (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ETHYLENE DIACETATE. See Ethylene Glycol Diacetate.

ETHYLENEDIAMINE

Synonyms: 1,2-ethanediamine; 1,2-diaminoethane.
Description: Volatile, colorless, hygroscopic liquid; ammonia-like odor.
Formula: $NH_2CH_2CH_2NH_2$
Constants:
Mol. Wt. 60.10
M. P. 8.5°C
B. P. 117.2°C
Flash P. 93°F (C.C.)
Density 0.8994 @20°/4°C
Vap. Press. 10.7 mm @20°C
Vap. D. 2.07
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (tentative); 10 parts per million in air. MLD for mice is 0.75 g/kg.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

ETHYLENE DIAMINE TETRA-ACETONITRILE

Synonym: EDTN
Description: White to cream colored powder.
Formula: $(NCCH_2)_2NCH_2CH_2N(CH_2CN)_2$
Constants:
Mol. Wt. 216
M. P. 132°C
Density 0.5 @25°C
Toxicity: Highly toxic. See Cyanides.

ETHYLENE DIBENZOATE

Description: Crystals.
Formula: $(C_6H_5CO_2)_2C_2H_4$
Constants:
Mol. Wt. 270.3
M. P. 73 - 74°C
B. P. 360°C Decomposes
Vap. D. 9.35
Toxicity: Probably moderate. See Ethylene Glycol and Benzoic Acid.
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials.
Storage and Handling: Section 7

ETHYLENE DIBROMIDE

Synonyms: 1,2-Dibromoethane; glycol dibromide.
Description: Colorless, heavy liquid; sweet odor.
Formula: CH_2BrCH_2Br
Constants:
Mol. Wt. 187.88
B. P. 131.4°C
Freezing P. 9.3°C
Flash P. None
Density 2.1701 @25°/4°C
Vap. Press. 17.4 mm @30°C
Vap. D. 6.48
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
MAC: 25 parts per million in air.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

ETHYLENE DIBUTYRATE

Synonym: Ethylene butyrate.
Description: Liquid.
Formula: $(CH_2O_2CCH_2CH_2CH_3)_2$
Constants:
  Mol. Wt. 202.3
  B. P. 240°C
  Density 1.024 @0°/4°C
  Vap. D. 6.96
Toxicity: Details unknown. See Butyric Acid.
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials.
Storage and Handling: Section 7

ETHYLENE DICHLORIDE

Synonyms: Ethylene chloride; dichloroethane.
Description: Colorless liquid.
Formula: CH_2ClCH_2Cl
Constants:
  Mol. Wt. 99.0
  B. P. 83.5°C
  Freezing P. −35.7°C
  Flash P. 70°F (O.C.)
  Density 1.257 @20°/4°C
  Autoign. Temp. 840°F
  Vap. Press. 100 mm @29.4°C
  Vap. D. 3.35
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: Irritant 2
  Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 2
MAC: ACGIH (accepted); 100 parts per million in air; 405 milligrams per cubic meter of air.
Toxicology: Ethylene dichloride has a distinctive odor and strong local irritating effects, which give warning of its presence in relatively safe concentrations. There is irritation of the eyes and upper respiratory passages. Ethylene dichloride has a specific effect on the cornea. Exposure to the vapor, or, in animals, injection under the skin, produces a clouding which may progress to endothelial necrosis and infiltration of the cornea by lymphocytes and connective tissue cells. The narcotic action of the compound is strong, probably of the same order as chloroform. Its toxic effects upon the liver and kidneys are less than that of carbon tetrachloride, but animal experiments indicate that these organs may show congestion and fatty degeneration. Edema of the lungs has also been reported in animals. Dermatitis in man has been observed (Section 9).

In short exposures to high concentrations, the picture is one of irritation of the eyes, nose and throat, followed by dizziness, nausea, vomiting, increasing stupor, cyanosis, rapid pulse, and loss of consciousness.

Chronic poisoning, where exposure has occurred over a period of several months, may cause loss of appetite, nausea and vomiting, epigastric distress, tremors, nystagmus, leucocytosis, low blood sugar levels, and possibly dermatitis if there has been skin contact. A soil fumigant.

Fire Hazard: Dangerous, if exposed to heat or flame.
Spontaneous Heating: No
Underwriters Laboratory Classification 60 - 70
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, in the form of vapor when exposed to flame (Section 7).
Explosive Range: 6.2 - 15.9%
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Inflammable liquid; red label.
  MCA warning label.

ETHYLENE DIFLUORIDE

Synonyms: Ethylene fluoride; 1,2-difluoro ethane.
Description: Colorless gas.

Formula: CH_2FCH_2F
Constants:
Mol. Wt. 66.1
B. P. 10 - 11°C
Vap. D. 2.28
Toxicity: Details unknown. See also Fluorides.
Fire Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides.
Storage and Handling: Section 7

ETHYLENE DIFORMATE. See Ethylene Glycol Diformate.

ETHYLENE DIIODIDE
Synonym: 1,2-Diodoethane.
Description: Yellow crystals.
Formula: CH_2ICH_2I
Constants:
Mol. Wt. 281.9
M. P. 82°C
B. P. Decomposes
Density 2.132 @10°/4°C
Vap. D. 9.72
Toxicity: Details unknown. See also Iodides.
Disaster Control: See Iodides.
Storage and Handling: Section 7

ETHYLENE DILAURATE
Synonym: Ethylene laurate.
Description: Solid.
Formula: $(C_{11}H_{23}CO_2CH_2)_2$
Constants:
Mol. Wt. 426.7
M. P. 52°C
B. P. 188°C @20 mm
Vap. D. 14.8
Toxicity: Details unknown.
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials.
Storage and Handling: Section 7

ETHYLENE DINITRATE
Synonym: Ethylene nitrate.
Description: Yellow liquid.
Formula: $C_2H_4(ONO_2)_2$
Constants:
Mol. Wt. 152.07
M. P. -20°C
B. P. Explodes @114°C
Density 1.483 @8°C
Vap. D. 5.25
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ETHYLENE DINITRITE
Synonym: Ethylene nitrite.
Description: Liquid.
Formula: $C_2H_4(ONO)_2$
Constants:
Mol. Wt. 120.1
M. P. < -15°C
B. P. 98°C
Density 1.2156 @0°/4°C
Vap. D. 4.13
Toxicity: Details unknown. See also Nitrites.
Fire Hazard: See Nitrites.
Explosion Hazard: See Nitrites.
Disaster Control: See Nitrites.
Storage and Handling: Section 7

ETHYLENE DITHIOCYANATE
Description: Colorless crystals.
Formula: $(CH_2SCN)_2$
Constants:
Mol. Wt. 144.2
M. P. 90°C
B. P. Decomposes
Vap. D. 4.98
Toxicity: Probably low. See also Thiocyanates.
Disaster Control: Dangerous! Will decompose when heated to give off highly toxic fumes.
Storage and Handling: Section 7

ETHYLENE GLYCOL
Synonyms: 1,2-Ethanediol; glycol; ethylene alcohol; glycol alcohol.
Description: Colorless, sweet-tasting liquid.
Formula: CH_2OHCH_2OH
Constants:
Mol. Wt. 62.1
B. P. 197.5°C
Freezing P. -13°C
Flash P. 232°F (C.C.)
Density 1.113 @25°/25°C
Autoign. Temp. 775°F
Vap. Press. 0.05 mm @20°C
Vap. D. 2.14

Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 3 (Lethal dose for man reported to be 100 ml.)
  Chronic Local: Irritant 1
  Chronic Systemic: Ingestion 1
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 3.2% (L.E.L.)
Personal Hygiene: Section 3
Storage and Handling: Section 7

ETHYLENE GLYCOL n-BUTYL ETHER

Description: Clear, mobile liquid; pleasant odor.
Formula: $C_4H_9OCH_2CH_2OH$
Constants:
  Mol. Wt. 118.2
  B. P. 168.4 - 170.2°C
  Freezing P. −74.8°C
  Flash P. 160°F (C.O.C.)
  Density 0.9012 @20°/20°C
  Vap. Press. 300 mm @140°C
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ETHYLENE GLYCOL -p-sec-BUTYLPHENYL ETHER

Synonym: 2-(p-sec-Butylphenoxy) ethanol.
Description: Straw-colored liquid.
Formula: $C_2H_5CH(CH_3)C_6H_4OCH_2CH_2OH$
Constants:
  Mol. Wt. 194.3
  M. P. < −20°C
  B. P. 151 - 161°C @10 mm
  Density 1.008 @25°/25°C
  Flash P. 300°F
  Vap. D. 6.7
Toxicity: See Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ETHYLENE GLYCOL p-tert-BUTYLPHENYL ETHER

Description: Light yellow liquid.
Formula: $(CH_3)_3CC_6H_4OCH_2CH_2OH$
Constants:
  Mol. Wt. 194.3
  M. P. 12.2°C
  B. P. 289 - 328°C @10 mm
  Flash P. 314.6°F
  Density 1.017 @25°/25°C
  Vap. D. 6.7
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ETHYLENE GLYCOL p-tert-BUTYLPHENYL ETHER ACETATE

Synonyms: 2-(p-tert Butylphenoxy) ethyl acetate.
Description: Slightly yellow liquid.
Formula: $(CH_3)_3CC_6H_4OCH_2CH_2OOCCH_3$
Constants:
  Mol. Wt. 236.3
  M. P. < −20°C
  B. P. 208°C
  Flash P. 327°F
  Density 1.029 @25°/25°C
  Vap. D. 8.15
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ETHYLENE GLYCOL DIABIETATE

Synonym: Glycol diabietate.
Description: Liquid.
Formula: $(CH_2CO_2C_{19}H_{29})_2$
Constants:
  Mol. Wt. 630.9
  Flash P. 520°F
  Vap. D. 21.8
Toxicity: Details unknown. See also Glycols.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

ETHYLENE GLYCOL DIACETATE

Synonyms: Ethylene acetate; glycol diacetate.

Description: Colorless liquid or crystals.

Formula: $(CH_2OOCCH_3)_2$

Constants:

Mol. Wt. 146.14
M. P. -31°C
B. P. 191°C
Flash P. 220°F (O.C.)
Density 1.128 @0°/4°C
Vap. Press. 1 mm @38.3°C
Vap. D. 5.04

Toxicity: Details unknown. See also Glycols.

Fire Hazard: Moderate when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

ETHYLENE GLYCOL DIBENZOATE

Synonym: Benzoflex; E-60.

Description: Crystalline material.

Formula: $(CH_2O_2CC_6H_5)_2$

Constants:

Mol. Wt. 270.2
B. P. 208 - 211°C
Freezing P. 69 - 71°C
Flash P. 365°F
Vap. D. 9.38

Toxicity: Details unknown. See also Glycols.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

ETHYLENE GLYCOL DIFORMATE

Synonyms: Ethylene formate; glycol diformate.

Description: Liquid.

Formula: $HCOOCH_2CH_2OOCH$

Constants:

Mol. Wt. 118.09
M. P. -10°C
B. P. 177°C
Flash P. 200°F
Density 1.2277 @20°/20°C
Vap. D. 4.07

Toxicity: Details unknown. See also Glycols.

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

ETHYLENE GLYCOL DIMETHYL ETHER

Synonym: 1,2-Dimethoxy ethane.

Description: Water-white liquid; ethereal odor.

Formula: $CH_3OCH_2CH_2OCH_3$

Constants: Mol. Wt. 90.1
B. P. 85.2°C
Flash P. 34°F (O.C.)
Freezing P. < -60°C
Density 0.8672 @20°/20°C
Vap. Press. 48 mm @20°C
Vap. D. 3.11

Toxicity: Details unknown. See also Glycols.

Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: See Ethers.

Disaster Control: Dangerous; upon exposure to heat or flame.

Ventilation Control (use moderate rate): Section 2

Storage and Handling: Section 7

ETHYLENE GLYCOL ETHYL ETHER

Description: Colorless liquid; mild pleasant odor.

Formula: $C_2H_5OCH_2CH_2OH$

Constants:

Mol. Wt. 90.1
B. P. 134.5°C
Flash P. 110°F (C.O.C.)
Density 0.9275 @25°/25°C
Vap. Press. 40 mm @60°C
Vap. D. 3.1

Toxic Hazard Rating:

Acute Local: Irritant 1; Ingestion 2; Inhalation 2

Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ETHYLENE GLYCOL METHYL BUTYL ETHER

Description: Liquid.
Formula: $C_4H_9OCH_2CH_2OCH_3$
Constants:
Mol. Wt. 132.2
B. P. 147°C
Density 0.8487
Vap. D. 4.57
Toxicity: Details unknown. See also Glycols.
Fire Hazard: See Ethers.
Storage and Handling: Section 7

ETHYLENE GLYCOL METHYL ETHER. See Ethylene Glycol Monomethyl Ether.

ETHYLENE GLYCOL METHYL n-HEXYL ETHER

Description: Liquid.
Formula: $C_6H_{13}OCH_2CH_2OCH_3$
Constants:
Mol. Wt. 160.25
B. P. 190°C
Density 0.855
Vap. D. 5.53
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Moderate; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ETHYLENE GLYCOL METHYL PHENYL ETHER

Description: Liquid.
Formula: $C_6H_5OCH_2CH_2OCH_3$
Constants:
Mol. Wt. 152.19
B. P. 215°C
Density 1.03
Toxicity: Details unknown. See also Glycols.
Storage and Handling: Section 7

ETHYLENE GLYCOL MONOACETATE

Synonym: Glycol monoacetate.
Description: Colorless, almost odorless liquid.
Formula: $CH_3COOCH_2CH_2OH$
Constants:
Mol. Wt. 104.10
B. P. 182°C
Flash P. 215°F (O. C.)
Density 1.108 @15°C
Vap. D. 3.59
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ETHYLENE GLYCOL MONOBUTYL ETHER. See Butyl "Cellosolve."

ETHYLENE GLYCOL MONOETHYL ETHER ACETATE. See "Cellosolve" Acetate.

ETHYLENE GLYCOL MONOISOPROPYL ETHER

Description: Colorless liquid; mild, agreeable odor.
Formula: $(CH_3)_2CHOCH_2CH_2OH$
Constants:
Mol. Wt. 104.14
B. P. 139°C
Density 0.906
Vap. D. 3.6
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Moderate; can react with oxidizing materials.
Storage and Handling: Section 7

ETHYLENE GLYCOL MONOMETHYL ETHER

Synonym: 2-Methoxyethanol.
Description: Colorless liquid; mild agreeable odor.
Formula: $CH_3OCH_2CH_2OH$

Constants:
- Mol. Wt. 76.09
- B. P. 124.5°C
- Freezing P. −86.5°C
- Flash P. 125°F (O.C.)
- Density 0.9660 @20°/4°C
- Autoign. Temp. 551°F
- Vap. Press. 6.2 mm @20°C
- Vap. D. 2.62

Toxic Hazard Rating:
- Acute Local: U
- Acute Systemic: Ingestion 2
- Chronic Local: Irritant 1
- Chronic Systemic: Ingestion 2; Inhalation 2

MAC: ACGIH (accepted); 25 parts per million in air; 76 milligrams per cubic meter of air.

Toxicology: When used under conditions which do not require the application of heat, this material probably presents little hazard to health. However, in the manufacture of fused collars, which require pressing with a hot iron, cases have been reported showing disburbance of the hemopoietic system with or without neurological signs and symptoms. The blood picture may resemble that produced by exposure to benzene. Two cases reported had severe aplastic anemia with tremors and marked mental dullness. One case had multiple neuritis and four others had abnormal reflexes. The commonest change in the blood picture was the finding of immature neutrophils (shift to the left); in other cases there were a reduction in number of the blood platelets and a macrocytic anemia. The persons affected had been exposed to vapors of methyl "Cellosolve" (76 ppm), ethyl and methyl alcohol, ethyl acetate and petroleum naphtha.

The first signs of poisoning are probably abnormalities found in the blood picture, as mentioned above. Reflexes may be exaggerated or abnormal in character, and may be accompanied by complaints of drowsiness and fatigue. Tremors may be present. Severe damage probably takes the form of an aplastic anemia.

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.

Spontaneous Heating: No

To Fight Fire: Carbon dioxide, dry chemical, or carbon tetrachloride (Section 6).

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations: Section 11.
- Coast Guard Classification: Combustible liquid.
- MCA warning label.

ETHYLENE GLYCOL MONOMETHYL ETHER ACETAL

Description: Liquid.

Formula: $CH_3CH(OCH_2CH_2OCH_3)_2$

Constants:
- Mol. Wt. 178.2
- M. P. −85°C (glass)
- B. P. 207.2°C
- Flash P. 205°F
- Density 0.9773 @20°/20°C
- Vap. Press. 0.1 mm @20°C
- Vap. D. 6.16

Toxicity: Details unknown. See also Glycols.

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

Shipping Regulations: Section 11
- Coast Guard Classification: Combustible liquid.

ETHYLENE GLYCOL MONOOCTYL ETHER

Description: Colorless, odorless liquid.

Formula: $C_4H_9CHC_2H_5CH_2OCH_2CH_2OH$

Constants:
- Mol. Wt. 174.28
- B. P. 228.3°C
- Flash P. 230°F
- Density 0.8859 @20°C
- Vap. Press. 0.02 mm @20°C

Toxicity: Unknown

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: See Ethers.
Storage and Handling: Section 7

ETHYLENE GLYCOL PHENYL ETHER

Synonym: Phenyl "Cellosolve"
Description: Colorless liquid.
Formula: $C_6H_5OCH_2CH_2OH$
Constants:
Mol. Wt. 138.16
B. P. 244.7°C
Freezing P. 14°C
Flash P. 250°F (O.C.)
Density 1.1094 @20°/20°C
Vap. Press. 0.03 mm @20°C
Vap. D. 4.8
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ETHYLENE GLYCOL PHENYL ETHER (commercial grade).

Synonyms: 2-Phenoxyethanol; Phenyl "Cellosolve"
Description: Pale straw-colored liquid.
Formula: $C_6H_5OCH_2CH_2OH$
Constants: Mol. Wt. 138.2
B. P. 245°C
Freezing P. 12°C
Flash P. 275°F
Density 1.105 @25°/25°C
Vap. D. 4.76
Toxicity: See Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: See Ethers.
Storage and Handling: Section 7

ETHYLENE GLYCOL PHENYL ETHER ACETATE

Synonyms: 2-Phenoxyethyl acetate
Description: Colorless, mobile. liquid.
Formula: $C_6H_5OCH_2CH_2OOCCH_3$
Constants:
Mol. Wt. 180.2
M. P. < -20°C
B. P. 231°C
Density 1.103 @25°/25°C
Flash P. 275°F
Vap. D. 6.2
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ETHYLENE IMINE

Synonyms: Ethylenimine; dimethylenimine.
Description: Oil; pungent, ammoniacal odor; water-white liquid.
Formula: $\underline{NHCH_2C}H_2$
Constants:
Mol. Wt. 43.07
B. P. 55 - 56°C
Freezing P. -71.5°C
Flash P. 12°F
Density 0.832 @20°/4°C
Autoign. Temp. 612°F
Vap. Press. 160 mm @20°C
Vap. D. 1.48
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (tentative); 15 parts per million in air.
Caution: Causes opaque cornea, keratoconus, and nercrosis of cornea (experimental). Has been known to cause severe human eye injury. Drinking of carbonated beverages is recommended as antidote to this material in stomach. See also Dimethylene Imine.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous. Heat and/or the presence of catalytically active metals or chloride ions can cause a violent exotheromic reaction. This material should be handled as per instructions of the manufacturer.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3

Personal Hygiene: Section 3
Storage and Handling: Section 7

ETHYLENE MONOCHLOROCHLORIDE

Synonym: Monochloroethylene chloride.
Formula: $CH_2ClCH_2Cl_2$
Constant:
Mol. Wt. 134.4
Toxicity: Details unknown, but probably toxic; a fumigant.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

ETHYLENE OXIDE

Synonyms: 1,2-Epoxyethane; oxirane.
Description: Colorless gas at room temperature.
Formula: $(CH_2)_2O$
Constants:
Mol. Wt. 44.05
M. P. -111.3°C
B. P. 10.7°C
Flash P. -4°F (O. C.)
Density 0.8711 @20°/20°C
Autoign. Temp. 1058°F
Vap. Press. 1095 mm @20°C
Vap. D. 1.52
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: Inhalation 2
Chronic Local: U
Chronic Systemic: Inhalation 1
MAC: ACGIH (accepted); 100 parts per million in air; 180 milligrams per cubic meter of air.
Fire Hazard: Dangerous, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
Underwriters Laboratory Classification: 100
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Severe, when exposed to flame.
Explosive Range: 3.0 - 100%
Disaster Control: Highly dangerous, upon exposure to heat or flame.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.
MCA warning label.

ETHYLENE SULFIDE

Synonym: Thiirane.
Description: Colorless liquid.
Formula: $(CH_2)_2S$
Constants:
Mol. Wt. 60.11
M. P. Decomposes
B. P. 55 - 56°C
Density 1.0368 @0°/4°C
Vap. D. 2.07
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur; can react with oxidizing materials.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ETHYLENE TRICHLORIDE

Synonyms: Ethinyl trichloride; trichloroethylene.
Description: Colorless liquid; chloroform-like-odor.
Formula: $CHClCCl_2$
Constants: Mol. Wt. 131.40
B. P. 87°C
Freezing P. -88°C
Flash P. None up to B. P.
Density 1.45560 @25°/4°C
Vap. Press. 60 mm @20°C
Vap. D. 4.53
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: Inhalation 2
Chronic Local: Irritant 1
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene.
Ventilation Control (use normal rate): Section 2

Personal Hygiene: Section 3
Storage and Handling: Section 7

ETHYLENE TRITHIOCARBONATE

Description: Bright yellow to brown, crystalline solid.
Formula: $C_3H_4S_3$
Constants:
  Mol. Wt. 136.3
  M. P. 34.5°C
  B. P. 117.5°C @0.6 mm
  Flash P. 330°F (T.C.C.)
  Density 1.48
  Vap. D. 4.70
Toxicity: Details unknown; avoid excessive skin contact, inhalation or ingestion of material.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react with oxidizing materials.
Storage and Handling: Section 7

ETHYL ETHANOLAMINE-1

Description: Liquid.
Formula: $C_2H_5NHC_2H_4OH$
Constants:
  Mol. Wt. 89.14
  M. P. −7.8°C
  B. P. 167°C
  Flash P. 160°F (O.C.)
  Density 0.9182 @20°/20°C
  Vap. Press. 0.4 mm @20°C
  Vap. D. 3.00
Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ETHYL ETHER

Synonyms: Sulfuric ether; anesthesia ether; ether; ethyl oxide.
Description: A clear, volatile liquid.
Formula: $C_2H_5OC_2H_5$
Constants:
  Mol. Wt. 74.12
  M. P. −116.2°C
  B. P. 34.6°C
  Flash P. −40°F (C.C.)
  Density 0.7135 @20°/4°C
  Autoign. Temp. 356°F
  Vap. Press. 442 mm @20°C
  Vap. D. 2.56
Toxic Hazard Rating:
  Acute Local: Ingestion 2; Inhalation 1
  Acute Systemic: Inhalation 2; Skin Absorption 2
  Chronic Local: U
  Chronic Systemic: U
MAC: ACGIH (accepted); 400 parts per million in air; 1212 milligrams per cubic meter of air.
Toxicology: Ether is not corrosive or dangerously reactive. However, it must not be considered safe for individuals to inhale or ingest. It is not toxic in the sense of being a poison. It is, however, a depressant of the central nervous system and is capable of producing intoxication, drowsiness, stupor, and unconsciousness. Death due to respiratory failure may result from severe and continued exposure.
Treatment and Antidotes: Removal from exposure almost always produces rapid and complete recovery.
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
Underwriters Laboratory Classification: 100
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Severe, when exposed to heat or flame.
Explosive Range: 1.85 - 36.5%
Disaster Control: Highly dangerous, in the presence of heat or flame.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Inflammable liquid; red label.
  MCA warning label.

ETHYL ETHER OF PROPYLENE GLYCOL

Description: Liquid.

Formula: $CH_2OC_2H_5CHOHCH_3$
Constants:
  Mol. Wt. 104.2
  Vap. D. 3.59
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2; Inhalation 1
  Chronic Local: U
  Chronic Systemic: Ingestion 1; Inhalation 1
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

ETHYL-3-ETHOXYPROPIONATE
Description: Liquid.
Formula: $C_2H_5OCH_2CH_2COOC_2H_5$
Constants:
  Mol. Wt. 146.18
  M. P. -100°C
  B. P. 170.1°C
  Flash P. 180°F (O.C.)
  Density 0.9496 @20°/20°C
  Vap. D. 5.03
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ETHYLETHYLENE ACETATE
Formula: $CH_2(CO_2CH_3)CH_2CHCH_2$
Constants:
  Mol. Wt. 114.1
  Vap. D. 3.93
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

ETHYL FLUORIDE
Synonym: Fluoroethane.
Description: Colorless gas.
Formula: CH_3CH_2F
Constants:
  Mol. Wt. 48.06
  M. P. -143.2°C
  B. P. -37.7°C
  Density 0.8158 @-37.7°C
  Vap. D. 1.66
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Inhalation 1
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of fluorides.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

ETHYLFLUOROFORMATE
Description: Liquid.
Formula: C_2H_5COOF
Constants:
  Mol. Wt. 92.07
  B. P. 57°C
  Density 1.11 @33°C
  Vap. D. 3.18
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, or on contact with acid or acid fumes, it emits toxic fumes of fluorides; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ETHYLFLUOROSULFONATE
Description: Liquid, ethereal odor.
Formula: $C_2H_5SO_3F$
Constants:
  Mol. Wt. 128.1
  Vap. D. 4.42
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of fluorides and oxides of sulfur;

will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ETHYL FORMATE
Synonyms: Formic ether; ethyl methanoate.
Description: Water-white liquid; pleasant, aromatic odor.
Formula: $HCOOC_2H_5$
Constants:
Mol. Wt. 74.08
M. P. -79°C
B. P. 54.3°C
Flash P. -4°F (C.C.)
Density 0.9236 @20°/20°C
Autoign. Temp. 1071°F
Vap. Press. 100 mm @5.4°C
Vap. D. 2.55
Toxicity: See Formic Acid.
MAC: ACGIH (accepted); 100 parts per million in air; 303 milligrams per cubic meter of air.
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Severe, when exposed to flame.
Explosive Range: 2.75 - 16.5%
Disaster Control: Highly dangerous; upon exposure to heat or flame.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.
MCA warning label.

ETHYL FORMATE, ANHYDROUS. See Ethyl Formate.

ETHYL GLYCOL. See "Cellosolve."

ETHYL GLYCOL ACETATE. See "Cellosolve" Acetate.

2-ETHYL HEXALDEHYDE
Synonym: Butyl ethyl acetaldehyde.
Description: Liquid.
Formula: $C_4H_9CH(C_2H_5)CHO$
Constants: Mol. Wt. 128.21
M. P. 100°C
B. P. 163.4°C
Flash P. 125°F (O.C.)
Density 0.8205
Vap. Press. 1.8 mm @20°C
Vap. D. 4.42
Toxicity: Details unknown. See also Aldehydes.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2,2-(2-ETHYL HEXANAMIDO) DIETHYL DI-(2-ETHYL HEXANOATE)
Description: Light brown liquid.
Formula:
$(C_7H_{15}OCOC_2H_4)_2NCOC_7H_{15}$
Constants:
Mol. Wt. 483.71
M. P. -33°C
B. P. 255°C @5 mm
Flash P. 420°F (O.C.)
Density 0.9564 @20°/20°C
Vap. Press. 0.31 mm @200°C
Vap. D. 16.7
Toxicity: Unknown.
Fire Hazard: Slight; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2-ETHYL HEXANE-DIOL-1,3
Description: Practically colorless, somewhat viscous, odorless liquid.
Formula:
$C_3H_7CH(OH)CH(C_2H_5)CH_2OH$
Constants:
Mol. Wt. 146.22
B. P. 243.1°C
Flash P. 260°F (O.C.)
Freezing P. -40°C
Density 0.9422 @20°/20°C
Vap. Press. < -0.01 mm @20°C
Vap. D. 5.03
Toxic Hazard Rating:
Acute Local: Irritant 1;

Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-ETHYL HEXANOIC ACID. See 2-Ethyl Hexoic Acid.

2-ETHYL HEXANOIC ANHYDRIDE

Synonym: Octoic anhydride.
Formula: $[CH_3(CH_2)_3CH(C_2H_5)CO]_2O$
Constants:
Mol. Wt. 270.39
Vap. D. 7.82
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials.
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-ETHYL HEXANOL. See 2-Ethylhexyl Alcohol.

ETHYL HEXANOYL CHLORIDE

Synonym: Caprylyl Chloride.
Description: Liquid.
Formula: $CH_3(CH_2)_6COCl$
Constants:
Mol. Wt. 162.66
Density 0.9671 @0°/4°C
M. P. -6°C
B. P. 195.55°C
Toxicity: An irritant material and a source of Hydrochloric Acid. See Hydrochloric Acid.
Fire Hazard: Moderate when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it evolves toxic chlorides.
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-ETHYL-1-HEXENE

Description: Colorless liquid.
Formula: C_8H_{16}
Constants:
Mol. Wt. 112.21
B. P. 120°C
Density 0.7270 @20°/20°C
Vap. D. 3.87
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits toxic fumes; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-ETHYL HEXOIC ACID

Synonyms: 3-Heptanecarboxylic acid; butylethylacetic acid.
Description: Mild-odored, colorless liquid.
Formula: $C_4H_9CH(C_2H_5)COOH$
Constants: Mol. Wt. 144.21
B. P. 227.6°C
Freezing P. -118.4°C
Flash P. 260°F (C.O.C.)
Density 0.903 @20°/4°C
Vap. Press. < .01 mm @20°C
Vap. D. 4.98
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbnn tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-ETHYLHEXYL ACETATE

Synonyms: Octyl acetate; beta-ethylhexyl acetate.
Description: Water-white, stable liquid.
Formula: $CH_3COOCH_2CHC_2H_5C_4H_9$
Constants: Mol. Wt. 172.26
M. P. -93°C
B. P. 199.3°C
Flash P. 180°F (O.C.)
Density 0.872 @20°/4°C

Vap. Press. 0.4 mm @20°C
Vap. D. 5.93
Toxicity: Slight. See Octyl Alcohol and Acetic Acid.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-ETHYLHEXYL ACRYLATE

Description: Liquid.
Formula:
$CH_2CHCO_2CH_2CH(C_2H_5)C_4H_9$
Constants:
Mol. Wt. 184.3
B. P. 130°C @50 mm
Freezing P. −90°C
Flash P. 180°F (O.C.)
Density 0.8869 @20°/20°C
Vap. Press. 1 mm @50.0°C
Vap. D. 6.35
Toxicity: Slight. See Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-ETHYLHEXYL ALCOHOL

Synonym: 2-Ethyl-1-hexanol; octyl alcohol.
Description: Liquid.
Formula: $C_4H_9CH(C_2H_5)CH_2OH$
Constants:
Mol. Wt. 130.23
B. P. 179 - 185.5°C
M. P. < −76°C
Flash P. 184°F
Density 0.834 @20°/20°C
Vap. Press. 0.2 mm @20°C
Vap. D. 4.49
Toxicity: Slight. See Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2-ETHYLHEXYLAMINE

Description: A clear, miscible liquid.
Formula: $C_4H_9CH(C_2H_5)CH_2NH_2$
Constants:
Mol. Wt. 129.24
B. P. 169.2°C
Flash P. 140°F (O.C.)
Density 0.7894 @20°/20°C
Vap. Press. 1.2 mm @20°C
Vap. D. 4.45
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-ETHYLHEXYL-3-AMINO PROPYL ETHER

Description: Liquid.
Formula:
$C_4H_9CH(C_2H_5)CH_2OC_3H_6NH_2$
Constants:
Mol. Wt. 187.32
B. P. 239°C
M. P. −90°C
Flash P. 210°F (O.C.)
Density 0.8483
Vap. D. 6.47
Toxicity: Details unknown. See also Ethers.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

N-2-ETHYLHEXYL ANILINE

Description: Liquid; mild odor.
Formula:
$C_6H_5NHCH_2CH(C_2H_5)(C_4H_9)$
Constants:
Mol. Wt. 205.3
B. P. 194°C @50 mm
Freezing P. < −70°C
Flash P. 325°F (C.O.C.)
Density 0.9119 @20°/20°C
Vap. Press. <0.01 @20°C
Vap. D. 6.9

Toxic Hazard Rating:
- Acute Local: Irritant 2; Ingestion 2; Inhalation 2
- Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 1
- Chronic Local: U
- Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3

Fire Hazard: Slight, when exposed to heat or flame.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; it will react with water or steam to produce toxic fumes; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-ETHYLHEXYL "CELLOSOLVE"

Description: Water-white liquid.
Formula: $C_4H_9CH(C_2H_5)CH_2OCH_2CH_2OH$
Constants:
- Mol. Wt. 174.28
- B. P. 228.3°C
- Flash P. 230°F
- Density 0.8859
- Vap. Press. 0.02 mm @20°C
- Vap. D. 6.02

Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2-ETHYLHEXYL-6-CHLORIDE

Description: Colorless liquid.
Formula: $C_4H_9CH(C_2H_5)CH_2Cl$
Constants:
- Mol. Wt. 148.67
- B. P. 172.9°C
- Freezing P. -135°C
- Flash P. 140°F (O.C.)
- Density 0.8833 @20°C
- Vap. D. 5.14

Toxic Hazard Rating:
- Acute Local: U
- Acute Systemic: Ingestion 2; Inhalation 2
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-ETHYLHEXYL ETHER

Description: Liquid.
Formula: $[C_4H_9CH(C_2H_5)CH_2]_2O$
Constants:
- Mol. Wt. 242.43
- M. P. -95°C
- B. P. 269.4°C
- Flash P. 235°F (O.C.)
- Density 0.8121 @20°/20°C
- Vap. D. 8.36

Toxicity: Details unknown. See also Ethers.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Slight, when exposed to heat, spark or flame.
Storage and Handling: Section 7

2-ETHYLHEXYL-2-ETHYLHEXANOATE

Description: Liquid.
Formula: $C_4H_9CH(C_2H_5)CH_2CO_2(C_2H_5)CHC_4H_9$
Constants:
- Mol. Wt. 256.4
- Vap. D. 8.85

Toxic Hazard Rating:
- Acute Local: Irritant 1
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials.
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-ETHYLHEXYL MERCAPTAN

Description: Colorless liquid.
Formula: $CH_3CH(C_2H_5)(CH_2)_4SH$

Constants:
Mol. Wt. 146.3
B. P. 90°C @35mm
Density 0.8543 @20°/20°C
Vap. D. 5.04
Toxicity: Details unknown. See also Mercaptans.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react with oxidizing materials.
Storage and Handling: Section 7

2-ETHYLHEXYL TITANATE

Synonym: Octyl titanate.
Description: Liquid.
Formula: $Ti[OCH_2CH(C_2H_5)(C_4H_9)]_4$
Constants:
Mol. Wt. 565
M. P. -55°C
B. P. 254°C
Density 0.93
Toxicity: See Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Storage and Handling: Section 7

ETHYLIDENE CHLORIDE

Synonyms: Ethylidene dichloride; chlorinated hydrochloric ether; 1,1-dichlorethane.
Description: Colorless liquid; aromatic, ethereal odor, hot saccharin taste.
Formula: CH_3CHCl_2
Constants:
Mol. Wt. 99.0
M. P. -96.7°C
B. P. 57.3°C
Flash P. 22°F (C.C.)
Density 1.174 @20°/4°C
Vap. Press. 230 mm @25°C
Vap. D. 3.44
Autoign. Temp. 856°F
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (accepted); 100 parts per million in air; 405 milligrams per cubic meter.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosion Range: 5.6 - 11.4% in air.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ETHYLIDENE DIFLUORIDE

Description: Gas.
Formula: CH_3CHF_2
Constants:
Mol. Wt. 66.1
M. P. -178°F
B. P. -24.7°C
Density 1.0
Vap. Press. 77.2 psia @70°F
Vap. D. 2.28
Toxicity: Details unknown. See also Fluorides.
Fire Hazard: Dangerous, when exposed to heat or flame.
Disaster Control: Dangerous; shock can shatter the compressed gas container with explosive force; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of fluorides; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

ETHYLIDENE DIIODIDE

Synonym: 1,1-Diiodoethane.
Description: Liquid
Formula: CH_3CHI_2
Constants:
Mol. Wt. 281.9
B. P. 179°C
Density 2.84 @0°/4°C
Vap. D. 9.74
Toxicity: Details unknown. See also Iodides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of iodides; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

ETHYL IODIDE

Synonyms: Hydriodic ether; iodoethane.

Description: Clear, colorless liquid; turns brown on exposure to light.

Formula: C_2H_5I

Constants:

Mol. Wt. 156.0

M. P. −105°C

B. P. 72.4°C

Density 1.90-1.93 @25°/25°C

Vap. Press. 100 mm @18.0°C

Vap. D. 5.38

Toxic Hazard Rating:

Acute Local: U

Acute Systemic: Inhalation 2

Chronic Local: U

Chronic Systemic: U

Fire Hazard: Moderate, when exposed to heat or flame.

To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of iodides; will react with water or steam to produce toxic and corrosive fumes; can react vigorously with oxidizing materials.

Ventilation Control (use normal rate): Section 2

Storage and Handling: Section 7

ETHYL IODOACETATE

Description: Dense, colorless liquid.

Formula: $CH_2ICOOC_2H_5$

Constants:

Mol. Wt. 214.02

B. P. 179°C

Density 1.80

Vap. Press. 0.54 mm @20°C

Vap. D. 7.4

Toxic Hazard Rating:

Acute Local: Irritant 3; Ingestion 3; Inhalation 3

Acute Systemic: U

Chronic Local: U

Chronic Systemic: U

Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of iodides; will react with water or steam to produce toxic and corrosive fumes.

Ventilation Control (use moderate rate): Section 2

Personnel Protection Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

ETHYL ISOBUTYRATE

Synonyms: Isobutyric ether; ethyl-2-methylpropanoate.

Description: Colorless, volatile liquid.

Formula: $(CH_3)_2CHCOOC_2H_5$

Constants:

Mol. Wt. 116.16

M. P. −88°C

B. P. 110 - 111°C

Density 0.870

Vap. Press. 40 mm @33.8°C

Vap. D. 4.01

Toxicity: See Isobutyric Acid.

Fire Hazard: Moderate, when exposed to heat or flame; can react vigorously with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

ETHYL ISOCYANATE

Formula: C_2H_5NCO

Constants:

Mol. Wt. 71.1

B. P. 60°C

Density 0.90 @20°/4°C

Vap. D. 2.45

Toxicity: Toxic. See also Isocyanates.

Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides.

Storage and Handling: Section 7

ETHYL ISOTHIOCYANATE

Synonym: Ethyl thiocarbimide.

Description: Colorless liquid; pungent odor.

Formula: C_2H_5NCS

Constants:

Mol. Wt. 87.2

M. P. −5.9°C

B. P. 131°C

Density 1.004 @15°/4°C

Vap. Press. 10 mm @22.8°C

Vap. D. 3.01

Toxic Hazard Rating:

Acute Local: Irritant 3; Ingestion 3; Inhalation 3

Acute Systemic: U

Chronic Local: U

Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur and cyanides; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ETHYL LACTATE

Synonym: Ethyl-2-hydroxy propanoate.
Description: Colorless liquid; mild odor.
Formula: $CH_3CHOHCOOC_2H_5$
Constants:
  Mol. Wt. 118.13
  B. P. 154°C
  Flash P. 115°F (C.C.)
  Density 1.020-1.036 @20°/20°C
  Autoign. Temp. 752°F
  Vap. D. 4.07
Toxicity: See Lactic Acid.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
Underwriters Laboratory Classification: 30 - 35
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Slight, when exposed to flame.
Explosive Range: 1.55% @212°F.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  Coast Guard Classification: Combustible liquid.

ETHYL LEVULINATE

Description: Colorless liquid.
Formula: $CH_3CO(CH_2)_2CO_2C_2H_5$
Constants:
  Mol. Wt. 144.2
  B. P. 206.2°C
  Density 1.012
  Vap. Press. 1 mm @47.3°C
  Vap. D. 4.97
Toxicity: Unknown
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials.
Storage and Handling: Section 7

ETHYL MAGNESIUM BROMIDE

Description: Solid.
Formula: C_2H_5MgBr
Constant:
  Mol. Wt. 133.3
Toxicity: See Bromides and Magnesium Compounds.
Fire Hazard: Moderate; it can evolve flammable ethane (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes of bromides; will react with water or steam to produce flammable vapors.
Storage and Handling: Section 7

ETHYL MAGNESIUM CHLORIDE

Description: Solid.
Formula: C_2H_5MgCl
Constant:
  Mol. Wt. 88.8
Toxicity: See Mangesium Compounds and Chlorides.
Fire Hazard: Moderate; it can react with moisutre to evolve ethane (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; will react with water or steam to produce flammable vapors.
Storage and Handling: Section 7

ETHYL MALONATE

Synonyms: Malonic ester; diethyl malonate.
Description: Colorless liquid; sweet odor.
Formula: $C_7H_{12}O_4$
Constants:
  Mol. Wt. 160.2
  M. P. -50°C
  B. P. 198°C
  Density 1.076 @0°C
  Vap. D. 5.53
Toxicity: Details unknown. See Esters.
Fire Hazard: Moderate; can react with oxidizing materials.
Storage and Handling: Section 7

ETHYL MANDELATE

Description: Crystals.
Formula: $C_6H_5CH(OH)CO_2CH_2CH_3$
Constant:
  Mol. Wt. 180.2
Toxicity: Details unknown. See Esters.

Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials.
Personal Hygiene: Section 3
Storage and Handling: Section 7

ETHYL MERCAPTAN

Synonyms: Ethanethiol; ethyl hydrosulfide; ethyl thioalcohol; ethyl sulfhydrate.
Description: Colorless liquid; pentrating garlic-like odor.
Formula: C_2H_5SH
Constants:
- Mol. Wt. 62.13
- M. P. −121°C
- B. P. 36.2°C
- Flash P. < 80°F (C.C.)
- Density 0.83907 @20°/4°C
- Autoign. Temp. 570°F
- Vap. D. 2.14

Toxic Hazard Rating:
- Acute Local: Irritant 2; Ingestion 2; Inhalation 2
- Acute Systemic: Ingestion 2; Inhalation 2
- Chronic Local: U
- Chronic Systemic: U

MAC: ACGIH (tentative); 250 parts per million in air.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to spark or flame.
Explosive Range: 2.8 - 18.2%
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur; will react with water or steam to produce toxic and flammable vapors; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
- Coast Guard Classification: Inflammable liquid; red label.

ETHYL MERCURY CHLORIDE

Synonym: Ethyl mercuric chloride.
Description: Silvery, iridescent leaflets.
Formula: C_2H_5HgCl
Constants:
- Mol. Wt. 265.13
- M. P. 192.5°C

Toxicity: See Mercury Compounds, Organic.
Disaster Control: See Mercury Compounds, Organic.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
- MCA warning label

ETHYL MERCURY CRESOL

Formula: $C_2H_5HgC_6H_4CH_3$
Constants:
- Mol. Wt. 320.8
- Vap. D. 11.05

Toxicity: See Mercury Compounds, Organic.
Disaster Control: See Mercury Compounds, Organic.
Storage and Handling: Section 7

ETHYL MERCURY ISOTHIOCARBAMIDE

Description: Crystals.
Formula: $C_2H_5HgNHCSNH_2$
Constants:
- Mol. Wt. 304.8
- Vap. D. 10.5

Toxicity: See Mercury Compounds, Organic.
Disaster Control: See Mercury Compounds, Organic.
Storage and Handling: Section 7

ETHYL MERCURY NITROPHENOL

Description: Crystals.
Formula: $C_2H_5HgC_6H_4NO_2$
Constants:
- Mol. Wt. 351.8
- Vap. D. 12.1

Toxicity: See Mercury Compounds, Organic.
Fire Hazard: See Nitrates.
Disaster Control: See Mercury Compounds, Organic.
Storage and Handling: Section 7

ETHYL MERCURY PHOSPHATE

Description: Solid
Formula: $C_2H_5HgH_2PO_4$
Constant: Mol. Wt. 326.7

Toxicity: See Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury and oxides of phosphorus.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

ETHYL MERCURY SULFATE

Description: Crystals.
Formula: $(C_2H_5Hg)_2SO_4$
Constant:
Mol. Wt. 555.4
Toxicity: See Mercury Compounds, Organic.
Disaster Control: See Mercury Compounds, Organic.
Storage and Handling: Section 7

ETHYL MERCURY-p-TOLUENE SULFONANILIDE

Formula:
$NH_2C_6H_4SO_3C_6H_3CH_3HgC_2H_5$
Constant:
Mol. Wt. 492.0
Toxicity: See Mercury Compounds, Organic.
Disaster Control: See Mercury Compounds, Organic.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

ETHYL METHACRYLATE

Description: A liquid.
Formula: $H_2CCCH_3COOC_2H_5$
Constants:
Mol. Wt. 114.07
M. P. < -75°C
B. P. 119°C
Flash P. 95°F (O.C.)
Density 0.911 @25°/25°C
Vap. D. 3.94
Toxicity: Details unknown. See Methacrylic Acid.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ETHYL METHYL ETHER

Synonym: Methoxyethane.
Description: Colorless liquid or gas.
Formula: $CH_3OC_2H_5$
Constants: Mol. Wt. 60.09
B. P. 7.5°C
Flash P. -35°F (C.C.)
Density 0.7260 @0°/4°C
Autoign Temp. 374°F
Vap. D. 2.07
Toxicity: Details unknown; but may have anesthetic properties. See also Ethers.
Fire Hazard: Highly dangerous; when exposed to heat or flame; can react vigorously with oxidizing materials. See also Ethers.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame. See also Ethers.
Explosive Range: 2.0 - 10.1%
Disaster Control: Highly dangerous, upon exposure to heat or flame.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

ETHYL METHYL KETONE

Synonyms: Methyl ethyl ketone; butanone.
Description: Colorless liquid.
Formula: $CH_3COC_2H_5$
Constants:
Mol. Wt. 72.10
M. P. -86.4°C
B. P. 79.6°C
Flash P. 24°F (C.C.)
Density 0.805 @20°/4°C
Autoign. Temp. 960°F
Vap. D. 2.48
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (accepted); 250 parts

per million in air; 735 milligrams per cubic meter of air.
Toxicology: Produces local irritation and narcosis. See also Ketones.
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
Underwriters Laboratory Classification 85 - 90.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 1.81 - 11.5%
Disaster Control: Highly dangerous, upon exposure to heat or flame.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Inflammable liquid; red label.

5-ETHYL-2-METHYL PYRIDINE

Synonym: Aldehydine.
Description: Liquid.
Formula $(C_2H_5)(CH_3)C_5H_3N$
Constants:
  Mol. Wt. 121.2
  B. P. 174°C
  Density 0.9184 @23°/4°C
Toxicity: Details unknown. See also Pyridine.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

ETHYL MORPHINE HYDROCHLORIDE. See Dionin

ETHYL N-MORPHOLINE

Description: Colorless liquid.
Formula: $\underbrace{CH_2CH_2OCH_2CH_2N}CH_2CH_3$
Constants:
  Mol. Wt. 115.2
  B. P. 138°C
  Flash P. 89.6°F (O.C.)
  Density 0.916 @20°/20°C
  Vap. D. 4.00
Toxicity: Unknown
Fire Hazard: Moderate when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7

ETHYL NITRATE

Synonym: Nitric ether.
Description: Colorless liquid; pleasant odor; sweet taste.
Formula: $C_2H_5ONO_2$
Constants:
  Mol. Wt. 91.07
  M. P. −112°C
  B. P. 88.7°C
  Flash P. 50°F (C.C.)
  Density 1.105 @20°/4°C
  Vap. D. 3.14
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat.
Explosive Range: 3.8% in air and @185°F for liquid.
Disaster Control: See Nitrates.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Inflammable liquid; red label.

ETHYL NITRITE

Synonyms: Nitrous ether; hyponitrous ether.
Description: Colorless or yellowish liquid; highly aromatic; ethereal odor.
Formula: C_2H_5ONO
Constants:
  Mol. Wt. 75.07
  B. P. 16.4°C

Flash P. −31°F (C.C.)
Density 0.900 @15.5°C
Autoign. Temp. 194°F
Vap. D. 2.59
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Highly dangerous when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical, carbon tetrachloride or water spray (Section 6).
Explosion Hazard: Severe.
Explosive Range: 3.0 - 50% in air and at 194°F for liquid.
Disaster Control: Highly dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of nitrogen; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

o-ETHYL NITROBENZENE

Synonym: 1-Ethyl-2-nitrobenzene.
Description: Clear yellow to green liquid.
Formula: $C_6H_4NO_2C_2H_5$
Constants:
Mol. Wt. 151.16
M. P. 23°C
B. P. About 228°C
Freezing P. −13°C
Density 1.1 @25°/25°C
Vap. D. 5.2
Toxicity: Details unknown; may resemble nitrobenzene.
Fire Hazard: See Nitrates.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

ETHYL OLEATE

Description: Light-colored oleaginous liquid.
Formula: $C_{17}H_{33}COOC_2H_5$
Constants:
Mol. Wt. 310.5
M. P. −32°C (approx.)
B. P. 205°C
Flash P. 347.5°F
Density 0.867
Toxicity: Details unknown. See Oleic Acid.
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

ETHYL OXALATE

Synonyms: Diethyl oxalate; diethyl ethanedioate; oxalic ether.
Description: Colorless, oily, aromatic liquid.
Formula: $(COOC_2H_5)_2$
Constants:
Mol. Wt. 146.14
M. P. −40.6°C
B. P. 185.4°C
Flash P. 168°F (C.C.)
Density 1.08426 @15°C; 1.0785 @20°/4°C
Vap. D. 5.04
Toxicity: Toxic. See Oxalates.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: On combustion, it will give off toxic fumes.
Storage and Handling: Section 7

ETHYL PHENYLACETATE

Description: Colorless liquid.
Formula: $C_6H_5CH_2COOC_2H_5$
Constants: Mol. Wt. 164.2
B. P. 276°C
Density 1.033 @20°C
Vap. D. 5.67
Toxicity: Details unknown. A weed killer.
Disaster Control: Moderately dangerous; when heated to decomposition, it may emit toxic fumes.

ETHYL PHENYL DICHLOROSILANE

Description: Liquid.

Formula: $C_2H_5SiCl_2C_6H_5$

Constants:

Mol. Wt. 205.06

Vap. D. 7.07

Toxic Hazard Rating:

Acute Local: Irritant 3; Ingestion 3; Inhalation 3

Acute Systemic: U

Chronic Local: U

Chronic Systemic: U

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and phenol; will react with water or steam to produce toxic and corrosive fumes; can react with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

Shipping Regulations: Section 11.

I. C. C. Classification: Corrosive liquid; white label.

Coast Guard Classification: Corrosive liquid; white label.

ETHYL PHOSPHINE

Synonym: Phosphinoethane.

Description: Colorless liquid.

Formula: $C_2H_5PH_2$

Constants:

Mol. Wt. 62.1

B. P. 25°C

Density < 1

Vap. D. 2.14

Toxicity: Details unknown. See also Phosphine.

Fire Hazard: Dangerous, when exposed to heat or flame.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Unknown

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus; can react vigorously with oxidizing materials.

Storage and Handling: Section 7

ETHYL PHTHALATE. See Diethyl Phthalate.

ETHYL PHTHALLYL ETHYL GLYCOLLATE

Description: Liquid.

Formula:

$C_2H_5OCOC_6H_4OCOCH_2OCOC_2H_5$

Constants:

Mol. Wt. 280.3

B. P. 608°F

Flash P. 365°F (C. C.)

Density 1.180

Vap. D. 9.6

Toxicity: Unknown

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

ETHYL PROPIONATE

Synonym: Propionic ether.

Description: Water-white liquid; pineapple-like odor.

Formula: $C_2H_5COOC_2H_5$

Constants: Mol. Wt. 102.11

M. P. −72.6°C

B. P. 99°C

Flash P. 54°F (C. C.)

Density 0.895 @15.5°C

Autoign. Temp. 890°F

Vap. Press. 40 mm @27.2°C

Vap. D. 3.52

Toxicity: Details unknown. See Propionic Acid.

Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.

Spontaneous Heating: No

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Unknown

Disaster Control: Dangerous, upon exposure to heat or flame.

Ventilation Control (use moderate rate): Section 2

Storage and Handling: Section 7

2-ETHYL-3-PROPYL ACROLEIN

Synonym: 2-Ethylhexenal.

Description: Colorless liquid; powerful odor.

Formula:

$CH_3(CH_2)_2CHC(C_2H_5)CHO$

Constants:

Mol. Wt. 126.19

B. P. 175°C

Flash P. 155°F (O. C.)

Density 0.848 @20°/4°C

Vap. D. 4.35

Vap. Press. 1.0 mm @20°C

Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-ETHYL-3-PROPYL ACRYLIC ACID

Description: Liquid.
Formula: $C_3H_7CHC(C_2H_5)COOH$
Constants: Mol. Wt. 142.19
  M. P. −7.8°C
  B. P. 232.1°C
  Density 0.948 @20°/20°C
  Vap. D. 4.91
Toxicity: Unknown
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

4-ETHYL PYRIDINE

Description: Liquid.
Formula: $CH_3CH_2C_5H_4N$
Constants: Mol. Wt. 107.1
  B. P. 168.3°C
  Density 0.9460 @20°/20°C
  Vap. D. 3.70
Toxicity: Details unknown. See also Pyridine.
Fire Hazard: Moderate.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react with oxidizing materials.
Storage and Handling: Section 7

ETHYL SELENIDE See Diethyl Selenide.

ETHYL SILICATE

Synonym: Tetraethyl-o-silicate.
Description: Colorless liquid; faint odor.
Formula: $(C_2H_5)_4SiO_4$
Constants: Mol. Wt. 208.30
  B. P. 165.5°C
  Flash P. 125°F (O. C.)
  Density 0.933 @20°/4°C
  Vap. Press. 1.0 mm @20°C
  Vap. D. 7.22
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: U
MAC: ACGIH (accepted); 100 parts per million in air; 851 milligrams per cubic meter of air.
Toxicology: Ethyl silicate is irritating to the eyes and upper respiratory tract. Concentrations of 2,500 ppm produce narcosis in guinea pigs after 1 ½ hours exposure. This is the maximum concentration obtainable at ordinary room temperatures by evaporation. The maximum concentration which these animals can inhale for 60 minutes without the production of serious disturbances is 2,000 ppm. For an exposure of several hours, concentrations of 500 ppm or more are required to cause serious injury. Animals dying after acute exposures show pulmonary edema, sometimes with secondary pneumonia, acute nephritis and evidence of injury to the liver. For humans, concentrations of 85 ppm produce a detectable odor, and 700 ppm cause stinging of the eyes and nose. No cases of human poisoning have been reported nor have experiments dealing with the effects of prolonged exposure been reported.

Irritation of the eyes and nose, tremors, respiratory difficulty or irregularity, anemia, leucocytosis, and narcosis have been reported in animal experiments. Brief exposures of humans to 3,000 ppm cause only extreme irritation of the eyes and nose.

Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Combustible liquid.

ETHYL SULFHYDRATE. See Ethyl Mercaptan.

ETHYL SULFIDE

Synonyms: Diethyl sulfide; thioethyl ether.
Description: Liquid; garlic-like odor.
Formula: $(C_2H_5)_2S$
Constants:
Mol. Wt. 90.2
M. P. −102°C
B. P. 92 - 93°C
Density 0.837 @20°/4°C
Vap. D. 3.11
Toxicity: Details unknown, but probably highly toxic.
Fire Hazard: Moderate. See also Sulfides (Section 6).
Disaster Control: Dangerous; when heated to decomposition, or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur; will react with water or steam to produce toxic and flammable vapors; can react with oxidizing materials.
Storage and Handling: Section 7

ETHYLSULFURIC ACID

Synonyms: Ethyl hydrogen sulfate; acid ethyl sulfate.
Description: Colorless, oily liquid.
Formula: $C_2H_5OSO_3H$
Constants:
Mol. Wt. 126.13
B. P. 280°C Decomposes
Density 1.316 @17°/4°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; will react with water or steam to produce heat.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ETHYL THIOCARBIMIDE. See Ethyl Isothiocyanate.

ETHYL-p-TOLUENE SULFONAMIDE

Description: Liquid.
Formula: $C_7H_7SO_2NHC_2H_5$
Constants:
Mol. Wt. 199.3
B. P. 208°F @745 mm
Flash P. 260°F (C.C.)
Density 1.253
Vap. D. 5.6
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react with oxidizing materials.
Storage and Handling: Section 7

ETHYL-p-TOLUENE SULFONATE

Description: Liquid.
Formula: $C_7H_7SO_3C_2H_5$
Constants:
Mol. Wt. 200.25
M. P. 33°C
B. P. 221.3°C
Flash P. 316°F (C.C.)
Density 1.17
Vap. D. 6.98
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react with oxidizing materials.
Storage and Handling: Section 7

ETHYL TRICHLOROSILANE

Description: Liquid.

Formula: $C_2H_5Cl_3Si$
Constants:
Mol. Wt. 163.47
M. P. −105.6°C
B. P. 99.5°C
Flash P. 72°F (O.C.)
Density 1.24 @25°/25°C
Vap. D. 5.6
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene; will react with water or steam to produce heat and toxic and corrosive fumes; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

ETHYLUREA
Description: Crystals.
Formula: $NH_2CONHC_2H_5$
Constants: Mol. Wt. 88.1
M. P. 92°C
Flash P. > 200°F
Density 1.213 @18°C
Toxicity: Details unknown, but may be toxic.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of cyanides; can react with oxidizing materials.
Storage and Handling: Section 7

ETHYL VANILLIN
Description: Fine, crystalline needles.
Formula: $C_6H_3(OH)(CHO)(OC_2H_5)$
Constants:
Mol. Wt. 166.17
M. P. 76.5°C
Toxicity: Unknown
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

m-ETHYL VINYL BENZENE
Synonym: Ethyl styrene.
Description: Water-white liquid.
Formula: $C_2H_5C_6H_4CHCH_2$
Constants:
Mol. Wt. 132.1
B. P. 191.5°C
Freezing P. −127°C
Density 0.8955 @20°C
Vap. Press. 2.17 mm @40°C
Vap. D. 4.56
Toxicity: Details unknown.
Fire Hazard: Moderate; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ETHYL VINYL ETHER
Synonym: Ethenoxy ethane.
Description: Liquid.
Formula: $CH_2CHOC_2H_5$
Constants: Mol. Wt. 72.1
M. P. −115°C. B. P. 35.5°C
Flash P. 0°F
Density 0.763 @15°/18°C
Vap. D. 2.49
Toxicity: Details unknown. See also Ethers.
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6)
Explosion Hazard: Details unknown. See also Ethers.
Disaster Control: Highly dangerous, upon exposure to heat or flame.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

ETHYNYL CYCLOHEXANOL
Synonym: 1-Ethynyl cyclohexan-1-ol
Description: Liquid or crystal.
Formula: $C_8H_{12}O$

Constants:
Mol. Wt. 124.18
M. P. 32°C
B. P. 180°C
Vap. D. 3.73
Toxicity: Details unknown. See also Alcohols.
Fire Hazard: Moderate; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

EUCALYPTUS OIL. See Oil of Eucalyptus.

EUROPIUM

Description: Gray crystals.
Formula: Eu
Constant:
At. Wt. 152.00
Toxicity: Unknown
Radiation Hazard (Section 5): Artificial isotope Eu^{154}, half-life: 5.4 years; emits beta particles of 0.3 mev (50%), 0.7 mev (40%) and 1.9 mev (10%) and gamma rays of 1.2 mev. The permissible levels are: In body: 22 microcuries. In air: 6×10^{-9} microcurie per milliliter. In water: 3×10^{-2} microcurie per milliliter.

EXPLOSIVES, HIGH

Description: High explosives (HE) are those which decompose by detonation. This is a very rapid (nearly instantaneous) process; hence the action is fast and violent. An explosion may be initiated by sudden shock,by high temperature or by a combination of the two. For many explosives the conditions under which they will explode are well known, for example:

An explosion may be initiated by elevated temperature alone:

(1) In the case of mercury fulminate 15 seconds exposure to 200°C or 1 second exposure to 340°C will set it off.

(2) Trinitrotoluene will be set off by exposure to 500°C for 1 second.

(3) Tetryl will detonate in 1000 seconds at 160°C or in 0.1 second at 500°C.

(4) Picric Acid will detonate in 9 seconds at 300°C or 1 second at 355°C.

An explosion of HE may alse be initiated by severe shock. Sensitivity of explosives to shock may be measured in several ways, such as the impact pendulum method and the drop test. The impact pendulum test operates by allowing a heavy pendulum to swing down over a sample of explosive in a dished, inclined container so arranged that there is very little clearance between the pendulum and the sample. Thus the effect of contact between the sample and the pendulum bob is one of a combination of shock and rubbing. The height from which the pendulum is allowed to swing to explode the sample is a measure of the sensitivity of the sample to this test. The drop test consists of placing a sample upon an anvil and allowing a 5 pound weight to drop on it. The height from which the weight must drop to explode the sample is a measure of the sample's sensitivity to shock.

Below is a table of the results of a drop test upon several samples. These results must be considered as relative and not by any means absolute. Solid explosive in a tightly fitting container is much more sensitive to shock.

(1) mercury fulminate = 2 inches at 5 pounds
(2) nitroglycerin = 4 inches at 5 pounds
(3) tetryl = 8 inches at 5 pounds
(4) picric acid = 14 inches at 5 pounds
(5) trinitrotoluene = 20 inches at 5 pounds
(6) black powder (a low explosive) = 30 inches at 5 pounds*

Another test for explosives is the speed at which a detonation travels. This speed is usually in the range of thousands of meters per second. Speed of detonation is found to be a function of kind of explosive and state of compaction. There is an optimum state of compaction beyond which the explosive tends to become "dead-pressed," in which state it is difficult to make the whole sample explode. Below the point of optimum compaction the rate of detonation is found to be directly proportional to the density of the sample. Below are listed some maximum detonation rates, in meters/second, for some common explosives:

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* From "Explosions, Their Anatomy and Destructiveness," by C. S. Robinson (McGraw-Hill)

(1) nitroglycerin	8500
(2) PETN	8100
(3) tetryl	7700
(4) picric acid	7500
(5) trinitrotoluene	7400
(6) lead azide	4900
(7) mercury fulminate	4800
(8) ammonium nitrate	1100
(9) low explosives	1000

It has been found that upon detonation an explosive can cause a nearby sample of explosive to detonate "sympathetically." The distance over which one charge can detonate another is a function of the amount of energy produced by the first explosion and the medium through which the shock wave is propagated to the second charge of explosive. For instance the relationship for air (very approximately) would be expected to be: Weight of explosive in pounds/(distance in feet)^3 = 4. Thus to calculate the maximum distance for a possible sympathetic detonation of 40,000 pounds of explosive, the calculation is:

$$(40,000)/4 = D^3$$

$$D^3 = 10,000$$

$$D = 22 \text{ feet (approximately)}$$

According to C. S. Robinson the formula is more nearly:
weight of explosive = $4 \times (\text{distance})^{2.25}$

The power of the shock wave is much more rapidly attenuated in water, wood, etc., than in air, which means that if a shield of water or wood is interposed between piles of explosive the distance between them may be lessened. (See also American Table of Distances in Section 7, Appendix I)

Liquid Oxygen. Though not by itself explosive, liquid oxygen can be dangerous when blended with highly flammable or carbonaceous materials. In this combination it is used in coal mining, quarrying, strip mining, and open-cut ore mining, and in rocket fuels. Its use underground or in confined places is not recommended by the U. S. Bureau of Mines, but it evolves a large percentage of carbon monoxide (See Carbon Monoxide). This type of explosive has many safety advantages. For instance, it is not itself an explosive until mixed with a flammable absorbent which can be done at the last moment before firing. However, once the explosive has been made up, it is very flammable and when it catches fire it will usually detonate. Liquid oxygen explosives are not stored, as they deteriorate rapidly and lose a great deal of their explosive power in a short time.

General Fire Hazard: Severe, when exposed to heat by chemical reaction with powerful oxidizing or reducing agents.

General Explosion Hazard: Moderate to dangerous when severely shocked or heated, depending upon kind of explosive, state of compaction, degree of confinement, etc. Practically all high explosives used commercially requires a detonator or cap to set them off, as compared to an igniter needed to set off black blasting powder (See also Explosives, Permissible; Dynamite; Nitroglycerin; Ammonium Nitrate; Nitrates, Trinitrotoluene).

Storage and Handling: See detailed description in Section 7.

Detonating Devices: To develop the desired disruptive effect of an explosive, some means must be adopted to "setoff," "fire," or "detonate" it without killing or maiming the persons doing the blasting. Several devices or methods are being utilized, all with a view to having this work done as safely and efficiently as possible. There are two general types of devices or methods of getting explosives into action, namely, igniters and detonators. The former merely convey a flame to the explosive mass and ignite it, while the latter transmit (originally through ignition of a small quantity of highly explosive substance by an arc, a flame, or spark) a sharp blow that causes the explosive to dissociate, or detonate, or burn with very great rapidity. Igniters are squibs (plain and electric), fuse, and delay igniters; detonators are blasting caps (plain and electric), delay electric blasting caps, delay electric igniters with caps, and Cordeau-Bickford detonating fuse.

The squib is a small-diameter tube of straw or paper filled with a quick-burning powder and having a relatively slow burning "match head" attached to one end; the latter is ignited or lighted by an ordinary match or other flame, and its relatively slow burning allows the person handling the ignition to retire before the fire is communicated to the quick-burning material in the tube. Squibs are by no means either safe or efficient, even though still used to a considerable extent, especially in coal mining. Electric squibs are somewhat similar to ordinary squibs, except that the ignition is accomplished by means of an electric arc; electric squibs are much more satisfactory from a safety viewpoint than ordinary squibs.

A fuse (or, as it is sometimes called, "safety fuse") consists of a fine-grained black powder core covered with cotton hemp or jute to form a rope-like material about 3/16 inch in diameter; one end of the fuse is brought in contact with the powder charge or with a detonating "cap," and the other end (usually several feet away from the explosive) is lighted by a flame from a match or open light. The fine-grained black powder burns gradually and somewhat slowly (about 30 to 40 seconds to the linear foot of fuse) until it reaches the explosive (black powder) or the detonating cap (if some form of dynamite is used), giving the blaster time to get in the clear before the main explosion takes place. Fuses are much safer than squibs, but have their own hazards and must be used with care.

Delay electric igniters usually are a combination of electric igniters and fuses, the latter being lighted by the igniters within the blasting hole, the fuse transmitting the ignition to the explosive. Delay igniters usually are much safer than fuse, particularly for coal-mine use; but they, too, have their hazards. Delay blasting is by no means a safe procedure in coal mining, though it is a standard and relatively safe practice in metal mining and tunneling, if sensible precautions are taken.

Blasting caps or detonators are metallic cylinders (usually copper) closed at one end, about 3/16 inch in diameter, and usually less than 2 inches in length, partly filled with a small amount of a relatively easily fired or "detonated" compound, the resultant shock or blow when fired being sufficient, when embedded in dynamite, to fire or detonate the dynamite mass. Ordinary blasting caps usually are fired or detonated by the flame of the fuse, the end of the latter being inserted into the open end of the detonator or cap and placed in contact with the highly explosive material in the interior of the metallic capsule or cap. Caps are extremely hazardous to handle, as they are likely to be detonated by heat, friction, or a relatively moderate blow; however, they are relatively safe if handled carefully. Partial proof of this is in the fact that they are manufactured and shipped by the thousands daily and accidents are decidedly rare, primarily because the caps are at all times handled with utmost care.

Electric blasting caps are somewhat similar to ordinary caps or detonators, but the cap is fired by electricity. The electric wires are so placed in the capsule or cap that when attached to an electric current an arc is formed within the cap, which detonates the sensitive explosive material in the cap. A hazard in the use of electric blasting caps is unexpected explosions due to radio or radar induced electric currents which may activate the cap.

Delay electric blasting caps or detonators are somewhat similar to ordinary electric blasting caps, except that several time intervals in blasting are obtained by having the electric arc ignite a short piece of fuse or some slow-burning substance before it reaches the highly sensitive detonating material in the capsule or cap. Numerous time-interval delays are obtained; in general delay electric blasting caps are relatively safe and effective even in wet holes, though they ought not be used in coal mining if explosions of gas or dust are to be avoided. Delay electric igniters with caps or detonators are a combination of electric igniter and blasting cap, usually with suitable lengths of fuse between to give the desired delay; they have some advantages but are relatively unsafe and should not be used in coal mining.

The Cordeau-Bickford detonating fuse is a combined fuse and detonator in the form of a lead tube about 1/4 inch in diameter filled throughout its length with a high explosive, trinitrotoluene (TNT). It is fired by fuse and an ordinary detonator or cap by an electric cap; when fired, it detonates throughout its length (which may be up to or over 100 feet) almost instantaneously, the explosion wave traveling at a rate of about 17,500 feet per second. Although somewhat expensive, it is relatively safe to handle and is particularly effective in deep-well drill holes in quarry and similar work, as it detonates simultaneously throughout its length, adding effectiveness to the main body of explosive which it detonates. It fires black powder as well as high explosives (dynamite, etc.) and is obtainable in lengths of approximately 500 feet, wound on spools.

Transportation of Explosives. In the transportation of explosives, the manufacturers and the railroads have set a most excellent example in safety, as is proved by the fact that accidents in rail transportation of explosives were so rare as to have been almost nonexistent in the past decade. The problem of transporting explosives from the railroad car to the users' magazines and from the magazines to the places of use (the mine, quarry, tunnel) is decidedly serious and should be given much more consideration than it usually receives. The Interstate Commerce Commission has issued numerous explicit regulations on the transportation of explosives, probably the most complete being "Regulations for the Transportation of Explosives and Other Dangerous Articles by Freight and Express and in Baggage Service," the most recent issue was in 1957.

Users of explosives who transport them by truck would profit by familiarizing themselves with the regulations established by the Interstate Commerce Commission. Railroad companies formulate and issue their own regulations for the transportation of explosives and other dangerous articles, and the restrictions of some of the carriers are drastic in the extreme. The Bureau of Explosives of the American Railway Association has issued much interesting information relating to the transportation of dangerous substances, including explosives of various kinds. The Bureau of Mines and other organizations have also issued information on the transportation of explosives, but much careless explosives-transportation practice occurs, not only in mining work but to an even greater extent in other activities in which explosives are used. State laws on transportation of explosives usually are confusing and inadequate; in fact, state laws on this subject usually are almost nonexistent or are phrased so broadly as to be almost meaningless.

EXPLOSIVES, LOW

Synonyms: Black blasting powder; gunpowder; "A" blasting powder; "B" blasting powder.

Composition: Black powder is composed of saltpeter, charcoal and sulfur in the approximate proportions of 6:1:1. ("A" blasting powder uses KNO_3 and "B" blasting powder uses $NaNO_3$). Low explosives are explosives which deflagrate; this differentiates them both in composition and properties from high explosives, which detonate. A deflagrating explosive is one that burns progressively over a relatively sustained period of time in comparison with a detonating explosive, which decomposes almost instantaneously. See also Section 7.

Toxicity: Variable

Fire Hazard: Dangerous, when exposed to heat or flame or by chemical reaction.

Although most safety men now look upon black blasting powder with disfavor, it is one of the oldest and most generally used explosives in commercial work. It burns with extreme rapidity instead of detonating as high explosives do; it is highly sensitive to flame or sparks or friction and gives off much flame, which is hot and of great length of duration. These properties make it extremely hazardous for use in mines (especially coal mines) and quarries. The gases given off in detonation are not only very hot but frequently contain harmful constituents. Notwithstanding its numerous dificiencies, from a safety standpoint, it has action characteristics that make it valuable in both coal mining and quarrying, though it has relatively little utility in metal mining. It is difficult to use effectively in wet places and this is its main disadvantage from an efficiency standpoint. Pellet powder is black blasting powder in consolidated (pellet or stick) form rather than in grains or granules, and it has few if any real advantages over black blasting powder, notwithstanding the fairly prevalent idea that it is a "safe" explosive.

Smokeless powders have a somewhat different composition from that of black blasting powder and are used chiefly for sportsmen's ammunition and, more widely, for military purposes. They are decidedly sensitive to flame and impact but ordinarily are so packaged that is reasonable judgment is used they are relatively harmless.

Most black powder fires start from sparks. Ignition results in an explosion so quickly that no attempt can be made to fight the fire. Every effort should be made to prevent fires from reaching stores of black powder; but if this fails, fire-fighting forces should be withdrawn at least 800 feet from the fire and should protect themselves against an explosion by seeking any cover available or by lying flat on the ground. If an explosion does occur, every effort should be made to prevent flames from spreading to neighboring magazines. Fire-fighting forces should be cautioned against approaching a fire which may involve black powder to avoid being trapped or injured by an explosion. Most explosions from black powder originate from sparks and the following safety rules should be strictly enforced and obeyed.

(1) Open no containers in a magazine in which explosives or ammunition are stored. This should be done only in a building free from all other explosives or ammunitions; or in suitable weather in the open, at least 100 feet from the nearest magazine. The quantity at or near such an operation should be limited to 100 pounds. Safety tools only should be used in opening or closing containers or in other operations involving black powder. Safety shoes (non-insulating) should be worn in all rooms where black powder is handled and by all persons engaged in handling black powder. The wearing of all non-conductive shoes, such as rubber is prohibited. If the handling of black powder is carried on over a concrete floor, the floor should be covered with a tarpaulin or other suitable material.

Loose black powder is extremely dangerous. Whenever it is necessary to handle loose black powder, not over 50 pounds should be permitted at or near such operations. If black powder is spilled on benches or floors, all work should be stopped until it has been removed and the explosive hazard of any remaining dust or particles has been neutralized with water. Rooms or buildings in which black powder is handled should be inspected frequently for dust, and all such dust should be immediately removed with water. See also Section 7.

Explosive Hazard: Severe, when exposed to heat or flame or by chemical reaction. Black powder is the slowest acting of all explosives. It has a shearing and heaving action, tending to blast materials in large, firm fragments. The action derives from a relatively slow development of gas pressure so that it must be carefully loaded and closely confined. The application is limited because it disintegrates in water and therefore cannot be used in wet work, except with special precautions. It also produces more smoke and fumes than most dynamites.

Precautions in Handling: Black powder is the most treacherous explosive material used today and it is regarded as one of the worst known explosive hazards. When ignited unconfined it burns with explosive violence and will explode if ignited under even slight confinement. It can be ignited easily by very small sparks, heat and friction. It is subject to rapid deterioration in the presence of moisture, but if kept dry it retains its explosive properties for many years. It is used to ignite smokeless powder, propelling charges, airplane flares and bursting charges of hand grenades, as a bursting charge in shrapnel, practice bombs, practice trench-mortar shells, in saluting charges, smoke-puff charges, time and percussion fuses, pellets, primers and primer detonators, and in expelling charges of pyrotechnic signals.

When black powder is shipped or received, each container should be inspected for holes and weak spots. It should be examined particularly for small holes, such as those made by nails, which are visible only upon close examination. Damaged containers should not be repaired. The contents should instead be transferred to new or serviceable containers. Metal containers for export shipment should be crated. Usually two containers are packed in each crate. Repainting of containers and repacking of black powder, contained in damaged or unserviceable containers, constitutes the principal maintenance activity for such stocks. Black powder containers are also subject to sweating, which rusts metal drums or kegs, so that repainting is necessary to keep containers serviceable. Repainting should not be done in a magazine in which explosives or ammunition are stored. It may be done in a nearly empty magazine, or in clear weather in the open, at least 100 feet from the nearest magazine. The quantity of black powder, at or near such operations should be limited to 100 pounds.

The marking on repainted containers should be checked carefully to see that it is a facsimile of the old. Furthermore, the metal caps on certain types of black powder containers deteriorate in storage. Replacement of these caps may be allowed, but the same safety precautions as outlined above for repainting containers should be followed. Operations, such as removal of black powder from containers and its transfer from unserviceable to serviceable drums should be conducted in strict compliance with applicable portions of the above outlined safety regulations. Black powder operations of any kind should be conducted in special buildings which are not used for other purposes at the same time. The floors of such buildings should be covered with suitable materials. Intraplant-quantity-distance requirements for high explosives as given in Section 7 should be followed. Absolute cleanliness should be maintained at all times in and around each operation. Non-insultating safety shoes should be worn by personnel in all assembly operations. All equipment should be electrically grounded and this should be determined by tests. Empty metal containers which have held black powder should be thoroughly washed inside with water before they are disposed of. Serious explosions have occurred from supposedly empty cans. Wooden containers should be destroyed by burning. Safety tools only should be used in opening or closing containers or in handling black powder. Processes should be so laid out as to bring about frequent grounding of all operators handling this material.

Destruction: Black powder is best destroyed by dumping it into water (preferably a stream or large body of water, but some states have anti-stream pollution laws that may be violated in this manner. It is well to be informed on this subject and to be certain that no damage will be done to water supplies.

If it is inconvenient or inadvisable

to destroy black powder thus, it may be burned. If that is done, the contents of only one container holding 25 pounds or less should be burned at a time. The powder should be poured on the ground in a trail not wider than 2 inches, and no part of such a trail should parallel another part at a distance of less than 10 feet. A train of combustible material should be laid to the explosive for igniting it, as with dynamite.

"Pellet powder" (black powder in compressed stick form) may be destroyed either by throwing it into water after removing the wrapper, or as described for dynamite. If dry and in good condition, black powder burns rapidly, especially in small grain size, with a yellow or pinkish-blue flame and dense smoke.

The empty powder containers should be washed out, as explosions are said to have occurred from "empty" containers.

Shipping Regulations: Class A Explosive. Not accepted as freight.

EXPLOSIVES, PERMISSIBLE

"Permissible" explosives are essentially high explosives (dynamite) modified by the introduction of "dopes." The function of the dopes in general is to decrease flame temperature and to a smaller extent, the length and duration of flame when the explosive is converted from a solid into a gas; in other words, when it is fired or detonated. The designation "permissible" is given to an explosive of modified dynamite type after it has passed certain tests made by the Federal Bureau of Mines. The permissible character of such explosives depends not only upon the ingredients in the explosive, but also on certain well-defined specifications as to handling and use. As with the dynamites, there are several different types and grades; "permissibles," hydrated "permissibles," organic nitrate "permissibles," nitroglycerin "permissibles," ammonium perchlorate "permissibles," and gelatin "permissible." Essentially all those now used to any extent are in either the ammonium nitrate or the gelatin classes. (See also Dynamite.)

The ammonium nitrate "permissible" explosives contain relatively little nitroglycerin and relatively large proportions of ammonium nitrate. The latter is an explosive but one less sensitive to impact, sparks, and flames than nitroglycerin. This type of "permissible" explosive is now used extensively, as it has a rather wide range of strength, rate of detonation, density, size of cartridge, etc., and can be utilized not only in dry but also to some extent in fairly wet holes if charged carefully and fired promptly. Gelatin "permissible," explosives are more suitable than ammonium nitrate "permissibles," for wet holes, and in general are stronger and more violent than the ammonium-nitrate types.

All "permissible" explosives are strong, must be used in relatively small quantities (less than 1½ pounds) per hole to retain their permissibility, give off considerable quantities of toxic gases on detonation, and, while much safer than black blasting powder or dynamite, must be stored, handled, and used with care.

Classification Upon Basis of Toxic Gases: All "permissible" explosives, when detonated, emit some toxic gases and a much larger volume of nontoxic gases. In order that the toxic products may not become a menace to the life or health of miners, no explosive is now or can become "permissible" if upon detonation it evolves more than 158 liters (5½ cubic feet) of toxic gases per 1½ pound charge as determined by tests in the Bichel pressure gage.

Classification upon the basis of the volume of toxic gases produced by 680 grams (1½ pounds) of explosive is as follows: Class A, not more than 53 liters; Class B, between 53 and 106 liters; and Class C, between 106 and 158 liters. (These classifications are not to be confused with the I. C. C. classification of explosives).

Field tests were made with a 1½ pound charge of a "permissible" explosive that produced, in the Bichel gage, the maximum allowable quantity of poisonous gases (158 liters per $1\frac{1}{2}$ pounds); these tests indicated that in a narrow entry, without artificial ventilation, 1800 ppm of carbon monoxide (the only poisonous gas present) was produced, as shown by analysis of an air sample taken 2 minutes after the shot. Another sample of the air taken 2 minutes later contained 800 ppm of carbon monoxide. Under no conditions should miners or shot firers return to the face until the poisonous gases have been removed by adequate ventilation.

It is provided further that, in accordance with the provisions and conditions, explosives enumerated on the "permissible" lists of the Bureau of Miners are "permissible" in use only when they satisfy the following requirements:

(1) That the explosive be in all respects similar to the sample submitted by the manufacturer for test, and that the diameters of the cartridges used must be those that have been approved.

(2) That electric detonators (not fuze and detonators) be used of not less efficiency than No. 6, the detonating charge of which shall consist of a 1 gram mixture of 80 parts of mercury fulminate and 20 parts of potassium chlorate (or their equivalents), and that the required electric firing must be done by means of a "permissible" type blasting unit.

(3) That the explosive be stored in surface magazines under proper conditions, so that it will not undergo change in character, and that after taking underground it be used in less than 36 hours.

(4) That the coal to be blasted be undercut or equivalently relieved; that, to prevent blow-through, all portions of the borehole must be at least 18 inches from relief in any direction; that, to prevent blowcuts, the charge be properly confined with not less than 2 feet of clay (if the length of the hole will not permit the charge desired and 2 feet of stemming, at least half the length of the hole shall be filled with stemming) or other incombustible stemming and not be on the solid; that, to prevent the hole being on the solid, it shall be at least 6 inches shorter than the depth of the undercut or equivalent relief, and, when placed adjacent to the roof, ribs, or floor, all but 12 inches at the rear of the hole must be at least 6 inches from the adjacent surface as projected into the coal to be blasted, and all parts of the hole shall be free from the adjacent surface as projected into the coal to be blasted; that the shot be not a dependent shot; and that the shot hole be cleaned before charging.

(5) That the quantity used for a shot (1) be not in excess of 680 grams ($1\frac{1}{2}$ pounds) when fired in accordance with these requirements and (2) when used under certain additional requirements or restrictions be not in excess of 1,361 grams (3 pounds). The use of charges over $1\frac{1}{2}$ pounds and not exceeding 3 pounds is approved tentatively pending further investigation. The approval, which may be withdrawn at any time, expires June 30, 1946, unless renewed. For charges of over $1\frac{1}{2}$ pounds, the following additional requirements must be observed; (a) Shot holes must be 6 feet or more in length. (b) Explosive must be charged in a continuous train, with no cartridges deliberately deformed or crushed, with all cartridges in contact with each other, and with the end cartridges touching the rear of the hole and the stemming, respectively. (c) Examinations for gas must be made in the blasting area before and after a shot is fired. (d) The "permissible" explosive must be one showing toxic gas emission that will place it in either Class A or Class B.

(6) That the region in which the blasting is done be kept well-protected by rock dust or otherwise in accordance with Bureau of Mines inspection standards.

(7) That the shot not be fired in the presence of a dangerous percentage of firedamp. Examination for firedamp to be made at the blasting area before shooting in a gassy mine.

See also articles on Dynamite, Nitroglycerin, Trinitrotoluene, Pentaerythritol Tetranitrate, Nitrates, Ammonium Nitrates, Picrates, Azides, Fulminates.

EXTRACTS, LIQUID FLAVORING

Constant:
  Flash P. Below 80°F
Toxicity: Variable; an allergen.
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11
  I. C. C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Combustible liquid; inflammable liquid; red label.

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FERRIC ARSENATE
Synonym: Scorodite.
Description: Rhombic, green crystals.
Formula: $FeAsO_4 \cdot 2H_2O$
Constants:
Mol. Wt. 230.78
M. P. Decomposes
Density 3.18
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

FERRIC ARSENIDE
Synonym: Iron arsenide.
Description: White powder.
Formula: FeAs
Constants:
Mol. Wt. 130.8
M. P. 1020°C
Density 7.83
Toxicity: Highly toxic. See Arsenic Compounds and Arsine.
Fire Hazard: See Arsine.
Explosion Hazard: See Arsine.
Disaster Control: See Arsenic Compounds and Arsine.
Storage and Handling: Section 7

FERRIC ARSENITE
Description: Brown-yellow powder.
Formula: $2FeAsO_3 \cdot Fe_2O_3 \cdot 5H_2O$
Constants:
Mol. Wt. 607.26
M. P. Decomposes
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

FERRIC BROMIDE
Description: Dark red-brown, deliquescent crystals.
Formula: $FeBr_3$
Constants:
Mol. Wt. 295.60
M. P. Sublimes with decomposition
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1
Acute Systemic: Ingestion 1
Chronic Local: U
Chronic Systemic: Ingestion 1
Fire Hazard: Slight; when heated, it emits toxic fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

FERRIC CACODYLATE
Description: Yellowish-brown, odorless powder.
Formula: $Fe[(CH_3)_2AsO_2]_3$
Constant:
Mol. Wt. 466.8
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

FERRIC CHLORIDE
Description: Black-brown solid.
Formula: $FeCl_3$
Constants:
Mol. Wt. 162.2
M. P. 282°C
B. P. 319.0°C
Density 2.804 @11°C
Vap. Press. 1 mm @194.0°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1
Acute Systemic: U
Chronic Local: Irritant 1
Chronic Systemic: U
Disaster Control: Dangerous; when

heated to decomposition, it emits highly toxic fumes of hydrochloric acid; will react with water to produce toxic and corrosive fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

FERRIC DIARSENIDE
Synonym: Iron diarsenide.
Description: Cubic, silver-gray crystals.
Formula: $FeAs_2$
Constants:
Mol. Wt. 205.7
M. P. 990°C
Density 7.4
Toxicity: Highly toxic. See Arsenic Compounds and Arsine.
Fire Hazard: See Arsine.
Explosion Hazard: See Arsine.
Disaster Control: See Arsenic Compounds and Arsine.
Storage and Handling: Section 7

FERRIC DICHROMATE
Description: Red-brown granules.
Formula: $Fe_2(Cr_2O_7)_3$
Constant:
Mol. Wt. 759.8
Toxicity: See Chromium Compounds.
Fire Hazard: Moderate, by chemical reaction with reducing agents (Section 6).
Storage and Handling: Section 7

FERRIC ETHYLENE BIS-DITHIOCARBAMATE
Toxicity: Details unknown; a fungicide.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

FERRIC FERRICYANIDE
Synonym: Berlin green.
Description: Cubes.
Formula: $Fe[Fe(CN)_6]$
Constant:
Mol. Wt. 267.8
Toxicity: Slight. See Ferricyanides.
Disaster Control: See Ferricyanides.
Storage and Handling: Section 7

FERRIC FERROCYANIDE
Description: Dark blue crystals.
Formula: $Fe_4[Fe(CN)_6]_3$
Constants:
Mol. Wt. 859.3
M. P. Decomposes
Toxicity: Slight. See Ferrocyanides.
Disaster Control: See Ferrocyanides.
Storage and Handling: Section 7

FERRIC FLUORIDE
Synonym: Iron fluoride.
Description: Green crystals.
Formula: FeF_3
Constants:
Mol. Wt. 112.9
Density 3.18
Toxicity: Highly toxic. See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

FERRIC FLUOSILICATE
Description: Gelatinous, flesh-colored solid.
Formula: $Fe_2(SiF_6)_3$
Constant:
Mol. Wt. 537.9
Toxicity: Hightly toxic. See Fluosilicates.
Disaster Control: See Fluosilicates.
Storage and Handling: Section 7

FERRIC FORMATE
Synonym: Iron formate.
Description: Red crystals.
Formula: $Fe(CHO_2)_3$
Constant:
Mol. Wt. 190.9
Toxicity: See Formic Acid.
Fire Hazard: Slight; when heated, it emits toxic fumes (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

FERRIC METHANEARSENATE
Description: Reddish-brown, lustrous scales.
Formula: $Fe_2(CH_3AsO_3)_3$
Constant:
Mol. Wt. 525.5
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

FERRIC NITRATE
Description: Crystals.
Formula: $Fe(NO_3)_3 \cdot 6H_2O$
Constants:
  Mol. Wt. 349.96
  M. P. 35°C
  Density 1.68
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 1
  Acute Systemic: Ingestion 1; Inhalation 1
  Chronic Local: Irritant 1
  Chronic Systemic: Ingestion 1; Inhalation 1
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

FERRIC OXALATE
Description: Yellow powder.
Formula: $Fe_2(C_2O_4)_3 \cdot 5H_2O$
Constants:
  Mol. Wt. 465.8
  M P. Decomposes @100°C
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 2
  Chronic Local: Irritant 1
  Chronic Systemic: Ingestion 1
Fire Hazard: Slight; when heated, it emits toxic fumes (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

FERRIC SULFIDE
Description: Yellow-green crystals.
Formula: Fe_2S_3
Constants:
  Mol. Wt. 207.90
  M. P. Decomposes
  Density 4.3
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 2; Inhalation 1
  Acute Systemic: Ingestion 1; Inhalation 2
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Personal Hygiene: Section 3
Storage and Handling: Section 7

FERRIC THIOCYANATE
Description: Cubic, black-red, deliquescent crystals.
Formula: $Fe(SCN)_3$
Constants:
  Mol. Wt. 230.10
  M. P. Decomposes
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 1
  Chronic Local: 0
  Chronic Systemic: 0
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides.
Personal Hygiene: Section 3
Storage and Handling: Section 7

FERRIC m- VANADATE
Synonym: Iron m-vanadate.
Description: Grayish-brown powder.
Formula: $Fe(VO_3)_3$
Constant:
  Mol. Wt. 352.70
Toxicity: See Vanadium Compounds.

FERRICYANIC ACID
Description: Green-brown, deliquescent needles.
Formula: $H_3Fe(CN)_6$
Constants:
  Mol. Wt. 215.0
  M. P. Decomposes
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 1
  Chronic Local: U
  Chronic Systemic: Ingestion 1
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides.
Personal Hygiene: Section 3
Storage and Handling: Section 7

FERRICYANIDES
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 1
  Chronic Local: U
  Chronic Systemic: Ingestion 1
Toxicology: Ferricyanides as such

are of low toxicity since the CN is bound. It has been stated but not conclusively proven that HCN can be liberated in the stomach as a result of contact with gastric acidity.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides.
Personal Hygiene: Section 3
Storage and Handling: Section 7

FERROCYANIC ACID
Description: White needles turning blue in moist air.
Formula: $H_4Fe(CN)_6$
Constants:
  Mol. Wt. 216.0
  M. P. Decomposes
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 1
  Chronic Local: U
  Chronic Systemic: Ingestion 1
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides.
Personal Hygiene: Section 3
Storage and Handling: Section 7

FERROCYANIDES
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 1
  Chronic Local: U
  Chronic Systemic: Ingestion 1; Inhalation 1
Toxicology: Ferrocyanides as such are of a low order of toxicity. But highly toxic decomposition products can form upon mixing them with hot concentrated acids. Acid, basic or neutral solutions of ferrocyanides liberate hydrocyanic acid upon strong irradiation.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides.
Personal Hygiene: Section 3
Storage and Handling: Section 7

FERROSILICON
Description: Crystalline, metallic solid.
Formula: Fe + Si
Constant:
  Density 5.4
Toxicity: Unknown. This material is decomposed by moisture, under which conditions impurities may liberate such poisonous gases as phosphine and arsine.
Fire Hazard: Moderate, by chemical reaction with moisture (Section 6).
Explosion Hazard: Moderate, by chemical reaction.
Disaster Control: Dangerous; it will react with water or steam to produce hydrogen and other flammable vapors; can react with oxidizing materials; and on contact with acid or acid fumes, it can emit toxic fumes.
Storage and Handling: Section 7
Shipping Regulations: Section 11
  Coast Guard Classification:
    Hazardous article.

FERROUS o-ARSENATE
Description: Green, amorphous powder.
Formula: $Fe_3(AsO_4)_2 \cdot 6H_2O$
Constants:
  Mol. Wt. 553.5
  M. P. Decomposes
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Poison B; poison label.
  Coast Guard Classification:
    Poison B; poison label.

FERROUS BROMIDE
Description: Hexagonal, green-yellow crystals.
Formula: $FeBr_2$
Constants: Mol. Wt. 215.7
  M. P. Decomposes
  Density 4.636 @25°C
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 1
  Chronic Local: U
  Chronic Systemic: Ingestion 1

Disaster Control: Dangerous, when heated to decomposition, it emits highly toxic fumes of hydrobromic acid.
Personal Hygiene: Section 3
Storage and Handling: Section 7

FERROUS CHLORIDE
Synonym: Lawrencite.
Description: Green to yellow, deliquescent crystals.
Formula: $FeCl_2$
Constants:
Mol. Wt. 126.8
M. P. 670 - 674°C
B. P. 1026°C
Density 2.98
Vap. Press. 10 mm @ 700°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1
Acute Systemic: Ingestion 1
Chronic Local: Irritant 1
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of hydrochloric acid.
Personal Hygiene: Section 3
Storage and Handling: Section 7

FERROUS CHLOROPLATINATE
Description: Yellow, hexagonal cyrstals.
Formula: $FePtCl_6 \cdot 6H_2O$
Constants:
Mol. Wt. 571.9
M. P. Decomposes
Density 2.714
Toxicity: See Platinum Compounds. Chloroplatinates generally tend to be highly irritating to the skin, but systemic poisoning is unknown.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of chlorides.
Storage and Handling: Section 7

FERROUS FERRICYANIDE
Description: Deep blue crystals.
Formula: $Fe_3[Fe(CN)_6]_2$
Constants:
Mol. Wt. 591.5
M. P. Decomposes
Toxicity: Slight. See Ferricyanides.
Disaster Control: See Ferricyanides.
Storage and Handling: Section 7

FERROUS FERROCYANIDE
Description: Amorphous, blue-white crystals.
Formula: $Fe_2Fe(CN)_6$
Constant:
Mol. Wt. 323.7
Toxicity: Slight. See Ferrocyanides.
Disaster Control: See Ferrocyanides.
Storage and Handling: Section 7

FERROUS FLUORIDE
Description: Crystals.
Formula: FeF_2
Constants:
Mol. Wt. 93.85
M. P. > 1000°C
Density 3.95 - 4.33
Toxicity: Highly toxic. See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

FERROUS FLUOSILICATE
Description: Trigonal, colorless crystals.
Formula: $FeSiF_6 \cdot 6H_2O$
Constants:
Mol. Wt. 306.0
Density 1.961
Toxicity: Highly toxic. See Fluosilicates.
Disaster Control: See Fluosilicates.
Storage and Handling: Section 7

FERROUS IODIDE
Description: Hexagonal, gray crystals.
Formula: FeI_2
Constants:
Mol. Wt. 309.7
M. P. 177°C
Density 5.315
Toxicity: Moderate. See Iodides.
Disaster Control: See Iodides.
Storage and Handling: Section 7

FERROUS NITRATE
Description: Rhombic, gray crystals.
Formula: $Fe(NO_3)_2 \cdot 6H_2O$
Constants:
Mol. Wt. 288.0
M. P. 60.5°C Decomposes
Toxicity: Moderate. See Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

FERROUS OXALATE
Description: Pale yellow powder.

Formula: $FeC_2O_4 \cdot 2H_2O$
Constants:
Mol. Wt. 179.90
M. P. Decomposes @160°C
Density 2.28
Toxicity: Highly toxic. See Oxalates.
Disaster Control: See Oxalates.
Storage and Handling: Section 7

FERROUS OXIDE
Description: Black crystals.
Formula: FeO
Constants:
Mol. Wt. 71.84
M. P. 1420°C
Density 5.7
Toxic Hazard Rating:
Acute Local: Irritant 1; Inhalation 1
Acute Systemic: 0
Chronic Local: 0
Chronic Systemic: 0
Personal Hygiene: Section 3

FERROUS PERCHLORATE
Description: Green crystals.
Formula: $Fe(ClO_4)_2 \cdot 6H_2O$
Constants:
Mol. Wt. 362.86
M. P. Decomposes > 100°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Inhalation 1
Acute Systemic: Ingestion 1
Chronic Local: Ingestion 1
Chronic Systemic: U
Fire Hazard: Moderate; a powerful oxidizer (Section 6).
Explosion Hazard: Moderate, when shocked, exposed to heat, or by chemical reaction.
Disaster Control: Dangerous; shock or heat will explode it; when heated to decomposition, it emits highly toxic fumes of oxides of chlorides; can react with reducing materials.
Personal Hygiene: Section 3
Storage and Handling: Section 7

FERROUS PYROARSENITE
Description: Green-white crystals.
Formula: $Fe_2As_2O_5$
Constant: Mol. Wt. 341.52
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

FERROUS SULFATE
Synonyms: Iron sulfate; copperas; green vitriol.
Description: Monoclinic crystals.
Formula: $FeSO_4 \cdot H_2O$
Constants:
Mol. Wt. 169.93
Density 2.99 - 3.08
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: 0
Chronic Local: 0
Chronic Systemic: 0
Personal Hygiene: Section 3

FERROUS SULFIDE
Synonym: Troilite.
Description: Black-brown crystals.
Formula: FeS
Constants:
Mol. Wt. 87.9
M. P. 1193°C
B. P. Decomposes
Density 4.84
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

FERROUS THIOCYANATE
Description: Rhombic green crystals.
Formula: $Fe(SCN)_2 \cdot 3H_2O$
Constants:
Mol. Wt. 226.07
M. P. Decomposes
Toxicity: Probably low. See Thiocyanates.
Disaster Control: See Thiocyanates.
Storage and Handling: Section 7

FERROVANADIUM DUST
Description: A gray to black dust.
Formula: FeV
Toxicity: See Vanadium Compounds and Iron Compounds.
MAC: ACGIH (tentative); 11 milligram per cubic meter of air.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: Slight, when exposed to flame.

FERTILIZER AMMONIATING SOLUTION CONTAINING FREE AMMONIA. See Ammonia and Compressed Gases, N.O.S.

Shipping Regulations: Section 11
I.C.C. Classification: Nonflammable gas; green label.
Coast Guard Classification: Noninflammable gas; green gas label.

FIBER, BURNT

Toxic Hazard Rating:
Acute Local: Irritant 1; Inhalation 1
Acute Systemic: 0
Chronic Local: Inhalation 1
Chronic Systemic: 0
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Slight, when exposed to heat or flame.
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

"FIBERGLAS"

Description: A fibrous form of glass.
Toxic Hazard Rating:
Acute Local: Irritant 2; Inhalation 1
Acute Systemic: 0
Chronic Local: Irritant 2
Chronic Systemic: U
Toxicology: This proprietary product is glass in the form of fine fibers. When handled by workers for a period of time, it can cause considerable skin irritation, particularly when in intimate contact with the skin. The possibility of lung injury due to inhalation of fine particles of this material has been raised repeatedly, but according to the best evidence available, pulmonary effects do not arise from this source. It has been reported that the dermatitis due to this material is caused by the mechanical impingement of tiny pieces of glass upon the skin during handling. Occasionally, it is thought to be due to the tricresyl phosphate which is added to the glass wool as a dust adhesive, or it is sometimes blamed upon the tar or phenolformaldehyde-resin binder which this material may contain. An examination of the minute lesions resulting from the handling of glass wool shows that these are never of an allergic eczematous character. With continued use, most workers become hardened to it and the temporary itching, swelling and redness subside. Reassurance and treatment with calamine lotion and phenol plus other protective measures takes care of about 95% of the cases.
Personnel Protection: Section 3
Personal Hygiene: Section 3

FIBERS OR FABRICS, WITH ANIMAL OR VEGETABLE OILS

Toxicity: Variable; possible allergen.
Fire Hazard: Moderate, when exposed to heat or flame; can react vigorously with oxidizing materials (Section 6).
Explosion Hazard: Moderate, when finely divided and exposed to flame.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

FIRE EXTINGUISHER CHARGES

See also Sulfuric Acid.
Shipping Regulations: Section 11.
I.C.C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

FIRE EXTINGUISHING GASES

Shipping Regulations: Section 11.
I.C.C. Classification: Nonflammable gas; green label.
Coast Guard Classification: Noninflammable gas.

FIREWORKS, COMMON. See Explosives, Low.
Shipping Regulations: Section 11.
I.C.C. Classification: Explosive C.
Coast Guard Classification: Explosive C.

FIREWORKS, SPECIAL. See Explosives, Low.

Shipping Regulations: Section 11.
I. C. C. Classification: Explosive B; special fireworks label.
Coast Guard Classification: Explosive B; special fireworks label.

FISCHER'S SALT. See Potassium Cobaltic Nitrite.

FISH OIL
Constant:
Flash P. About 420°F
Toxicity: May act as irritants to the skin or as allergens; insecticides when combined with sodium or potassium base as a soap.
Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: Yes
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Hazardous article.

FISH SCRAP, DRY
Toxicity: Details unknown, a mild allergen; a nuisance dust.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Hazardous article.

FISH SCRAP OR FISH MEAL WITH LESS THAN 6% OR MORE THAN 12% MOISTURE
Toxicity: Details unknown; a mild allergen; a nuisance dust.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

FLOUR
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1
Acute Systemic: Inhalation 2
Chronic Local: Allergen 1; Inhalation 1
Chronic Systemic: Inhalation 1
Fire Hazard: Moderate in the form of dust.
Explosion Hazard: Moderate in the form of dust, when exposed to heat or flame (Section 6). Severe flour dust expolsions have occurred in grain elevators and processing plants.
Ventilation Control (use moderate rate): Section 2
Perosnal Hygiene: Section 3
Storage and Handling: Section 7

FLUE DUST
Toxicity: Variable; depends on composition.
Fire Hazard: Moderate (Section 6).
Explosion Hazard: Moderate, when exposed to flame or spark.
Ventilation Control (use moderate rate): Section 2
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

FLUOACETATES
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: Ingestion 3
Chronic Local: Irritant 2
Chronic Systemic: Ingestion 2; Inhalation 2
Disaster Control: Dangerous; when heated to decompositon or on contact with acid or acid fumes, they emit highly toxic fumes of fluorides.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

FLUOACETIC ACID
Synonym: Fluoroacetic acid.
Description: Colorless crystals.
Formula: CH_2FCOOH
Constants:
Mol. Wt. 78.04
B. P. 165°C
M. P. 33°C
Toxicity: Moderate. See Fluoacetates.

Disaster Control: See Fluoacetates.
Storage and Handling: Section 7

FLUOALUMINATES

Toxicity: Details unknown. See also Fluorides.
Disaster Control: Dangerous; when heated to decompositon or on contact with acid or acid fumes, it emits highly toxic fumes of fluorides.
Storage and Handling: Section 7

FLUOANTIMONATES

Toxicity: See Fluorides and Antimony Compounds.
Disaster Control: See Fluorides and Antimony Compounds.
Storage and Handling: Section 7

FLUOBERYLLATES

Toxic Hazard Rating:
- Acute Local: Irritant 3; Inhalation 3
- Acute Systemic: Inhalation 3
- Chronic Local: Inhalation 3
- Chronic Systemic: Ingestion 3; Inhalation 3

Disaster Control: See Fluorides and Beryllium Compounds.
Ventilation Control (use high rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

FLUOBORATES

Toxicity: Highly toxic. See Fluorides.
Disaster Control: See Fluorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

FLUOBORIC ACID

Description: Colorless liquid.
Formula: HBF_4
Constants:
- Mol. Wt. 87.8
- B. P. Decomposes @130°C

Toxicity: Highly toxic. See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

FLUOGALLATES

Toxicity: Probably high. See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

FLUOGERMANATES

Toxicity: Probably high. See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

FLUOPHOSPHATES

Toxicity: Highly toxic. See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

FLUOPHOSPHORIC ACIDS

Description: A term used to designate several acids containing fluorine and phosphorus (from H_2PO_3F to HPF_6).
Toxicity: Highly toxic. See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

FLUORANTHENE

Description: Colorless solid.
Formula: $C_{16}H_{10}$
Constants:
- Mol. Wt. 202.24
- M. P. 102°C
- B. P. 367°C
- Vap. Press. < 0.01 mm @20°C

Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Storage and Handling: Section 7

FLUORENE

Synonym: o-Biphenylene methane.
Description: White, shining flakes.
Formula: $C_{13}H_{10}$
Constants:
- Mol. Wt. 166.2
- M. P. 113°C
- B. P. 295°C
- Density 1.202
- Vap. Press. 10 mm @146.0°C

Toxicity: Unknown
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

FLUORESCEIN

Synonym: Resorcinol phthalein.

Description: Orange-red, crystalline powder.
Formula: $C_{20}H_{12}O_5$
Constants:
  Mol. Wt. 332.3
  M. P. 314 - 316°C with Decomp.
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits smoke (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

FLUORIDES

Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3
  Chronic Local: Irritant 1
  Chronic Systemic: Ingestion 3; Inhalation 3
MAC: ACGIH (accepted); 2.5 milligrams per cubic meter of air.
Toxicology: Inorganic fluorides are generally highly irritant and toxic. Acute effects resulting from exposure to fluorine compounds are due to hydrogen fluoride. Chronic fluorine poisoning, or "fluorosis," occurs among miners of cryolite, and consists of a sclerosis of the bones, caused by fixation of the calcium by the fluorine. There may alse be some calcification of the ligaments. The teeth are mottled, and there is osteosclerosis and osteomalacia. The bony and ligamentous changes are demonstrable by x-ray.

Loss of weight, anorexia, anemia, wasting and cachexia, and dental defects are among the common findings in chronic fluorine poisoning. There may be an eosinophilia, and impairment of growth in young workers.

Organic fluorides are generally less toxic than other halogenated hydrocarbons.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, they emit highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

FLUORINE

Description: Pale yellow gas.
Formula: F_2
Constants:
  Mol. Wt. 38.0
  M. P. -223°C
  B. P. -187.0°C
  Density 1.14 @-200°C; 1.108 @-188°C
  Vap. D. 1.695
Toxic Hazard Rating:
  Acute Local: Irritant 3; Inhalation 3
  Acute Systemic: Secondary to local action.
  Chronic Local: Irritant 2; Inhalation 2
  Chronic Systemic: U
MAC: ACGIH (accepted); 0.1 part per million in air.
Fire Hazard: Dangerous, by chemical reaction with reducing agents (Section 6).
Disaster Control: Highly dangerous; shock can shatter the compressed gas container with explosive force; when heated, it emits highly toxic fumes; will react with water or steam to produce heat, toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable gas; red gas label.
  Coast Guard Classification: Inflammable gas; red gas label.

FLUOROACETOPHENONE

Synonym: Phenacyl fluoride.
Description: Brown liquid; pungent odor.
Formula: $C_6H_5COCH_2F$
Constant:
  B. P. 98°C @8 mm
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: See Fluorides.

Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

FLUOROFORM

Synonym: Trifluoromethane.
Description: Colorless gas.
Formula: CHF_3
Constants:
- Mol. Wt. 70.02
- M. P. −163°C
- B. P. −82.2°C

Toxic Hazard Rating:
- Acute Local: U
- Acute Systemic: Inhalation 2
- Chronic Local: U
- Chronic Systemic: U

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

FLUOROTRICHLOROMETHANE

Synonym: "Freon 11."
Description: Colorless liquid.
Formula: $FCCl_3$
Constants:
- Mol. Wt. 137.38
- M. P. −111°C
- B. P. 24.1°C
- Density 1.494 @17.2°C

Toxic Hazard Rating:
- Acute Local: Irritant 1; Ingestion 1; Inhalation 1
- Acute Systemic: Ingestion 1; Inhalation 1; Skin Absorption 1
- Chronic Local: Irritant 1
- Chronic Systemic: Ingestion 1; Inhalation 1; Skin Absorption 1

MAC: ACGIH (accepted); 1000 parts per million in air.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides.
Storage and Handling: Section 7

2-FLUORYLAMINE

Formula: $C_6H_4CH_2C_6H_3NH_2$
Constant:
- Mol. Wt. 181.3

Toxicity: Details unknown; a stomach insecticide. See also Amines.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

FLUOSILICATES

Synonym: Silicofluorides.
Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: Ingestion 3; Inhalation 3
- Chronic Local: Irritant 2; Ingestion 2; Inhalation 2
- Chronic Systemic: Ingestion 3; Inhalation 3

Disaster Control: See Fluorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

FLUOSILICIC ACID

Description: Transparent, colorless, fuming liquid.
Formula: H_2SiF_6
Constants:
- Mol. Wt. 144.1
- M. P. 144.1°C
- B. P. Decomposes
- Density 1.29 - 1.31 @15°C

Toxicity: Highly toxic. See Fluosilicates.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

FLUOSULFONATES

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: Ingestion 2; Inhalation 2

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides and oxides of sulfur; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

FLUOSULFONIC ACID

Synonym: Fluosulfuric acid.

Description: Colorless, fuming, highly corrosive liquid.
Formula: HSO_3F
Constants:
- Mol. Wt. 100.07
- M. P. −87.3°C
- B. P. 165.5°C
- Density 1.743 @15°C

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: Ingestion 2; Inhalation 2

Disaster Control: See Fluosulfonates.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
- I. C. C. Classification: Corrosive liquid; white label.
- Coast Guard Classification: Corrosive liquid; white label.

FLUOTELLURITES

Toxicity: Details unknown. See also Fluorides and Tellurium Compounds.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

"FLURAL"

Description: Dry, free-flowing powder.
Formula:
$AlFSO_4 \cdot xH_2O$ to $Al_2F_4SO_4 \cdot xH_2O$
Toxicity: Highly toxic. See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

FLUX, BLACK. Dangerous! A low explosive. For details, see Explosives, Low.

FLUX, WHITE

Composition: Sodium nitrate and sodium nitrite. See Nitrates.
Fire Hazard: Dangerous. This is a strong oxidizing agent.
Disaster Control: Keep away from heat and open flame; do not store near reducing agents or easily oxidized materials.
Storage and Handling: Section 7

FORMALDEHYDE (COMMERCIAL SOLUTIONS)

Synonyms: Methanal; methyl aldehyde; formalin.
Description: Clear, water-white, very slightly acid, gas or liquid; pungent odor. Pure formaldehyde is not available commercially because of its tendency to polymerize. It is sold as aqueous solutions containing from 37% to 50% formaldehyde by weight and varying amounts of methanol. Some alcoholic solutions are used industrially and the physical properties and hazards may be greatly influenced by the solvent.
Formula: HCHO
Constant:
- Mol. Wt. 30.03

Toxic Hazard Rating:
- Acute Local: Irritant 1; Allergen 1; Ingestion 3; Inhalation 3
- Acute Systemic: Ingestion 2; Inhalation 2
- Chronic Local: Irritant 1; Allergen 1
- Chronic Systemic: U

MAC: ACGIH (accepted); 5 parts per million in air; 6 milligrams per cubic meter in air for 8-hour day exposure.
Caution: Frequent or prolonged exposure can cause hypersensitivity.
Fire Hazard: Moderate; vapors will burn above flash point if exposed to flame, sparks, etc. Should formaldehyde be involved in a fire, irritating gaseous formaldehyde may be involved in a fire, irritating gaseous formaldehyde may be evolved.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical, foam, or water spray (Section 6).
Explosion Hazard: When acqueous formaldehyde solutions are heated above their flash points, a potential explosion hazard exists. Higher formaldehyde concentrations or methanol content lower the flash point.
Explosive Range: Formaldehyde gas or vapors from solutions - 7.0% to 73.0%.
Disaster Control: Moderately dangerous; because of irritating

vapor which may be in toxic concentrations locally if storage tank is ruptured.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Combustible liquid.
MCA warning label.

FORMALIN. See Formaldehyde.

Formalin was originally used as a European trade name for 37% formaldehyde solution. It is commonly employed as a synonym for commercial formaldehyde.

FORMAMIDE

Synonym: Methanamide.
Description: Colorless, hygroscopic and oily liquid.
Formula: $HCONH_2$
Constants:
Mol. Wt. 45.04
M. P. 2.55°C
B. P. 210.7°C Decomposes
Density 1.134 @20°/4°C; 1.1292 @25°/4°C
Vap. Press. 1 mm @70.5°C
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

FORMIC ACID

Synonyms: Methanoic acid; hydrogen carboxylic acid.
Description: Colorless, fuming liquid; pungent, penetrating odor.
Formula: HCOOH
Constants:
Mol. Wt. 46.03
B. P. 100.8°C
Freezing P. 8.2°C
Flash P. 156°F (O.C.)
Density 1.2267 @15°/4°C; 1.220 @20°/4°C
Autoign. Temp. 1114°F
Vap. Press. 40 mm @24.0°C
Vap. D. 1.59
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3
Chronic Local: Irritant 2
Chronic Systemic: Ingestion 1
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.
MCA warning label.

FORMYL FLUORIDE

Description: Colorless, mobile liquid.
Formula: HCOF
Constants: Mol. Wt. 48.02
B. P. −26°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
Fire Hazard: Moderate, by chemical reaction (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of fluorides; it will react with water or steam to produce toxic fumes, such as carbon monoxide.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

FRENCH POLISH

Description: Shellac dissolved in alcohol.
Toxicity: See Alcohol and Shellac.
Fire Hazard: Moderate, when

exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

"FREON-11." See Fluorotrichloromethane.

"FREON-12." See Dichlorodifluoromethane.

"FREON-21." See Dichlorofluoro methane.

"FREON-112." See Tetrachlorodifluoroethane.

"FREON-113." See Trifluorotrichloroethane.

FUEL OIL NO. 1. See Kerosene.

FUEL OIL NO. 2. See Diesel Oil.

FUEL OIL NO. 3.

Description: Somewhat viscous, brown, odoriferous liquid.
Constants:
Flash P. 110 - 230°F (C.C.)
Density Less than 1
Autoign. Temp. 498°F
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

FUEL OIL NO. 4

Description: Moderately viscous, dark, odoriferous liquid.
Constants:
Flash P. 150°F (C.C.)
Density Less than 1
Autoign. Temp. 505°F
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Combustible liquid.

FUEL OIL NO. 5

Synonym: Navy special.
Description: Viscous, oily liquid.
Constants:
Flash P. 130+°F
Density Less than 1
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Combustible liquid.

FUEL OIL NO. 6

Description: Very viscous, dark colored, odoriferous liquid.
Constants:
Flash P. 150+°F
Density Less than 1
Autoign. Temp. 765°F
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

FULMINATE OF MERCURY, DRY

Description: White solid.
Formula: $HgC_2N_2O_2$
Constants:
Mol. Wt. 284.7
M. P. Explodes
Density 4.42
Toxicity: See Mercury Compounds, Organic.
Fire Hazard: Dangerous! Material should be kept moist till used.
Explosion Hazard: See Fulminates.
Disaster Control: Highly dangerous. See Fulminates.
Storage and Handling: Section 7
Shipping Regulations: Section 11.

I.C.C. Classification: Forbidden explosive.
Coast Guard Classification: Prohibited.

FULMINATES

Toxicity: Variable.
Fire Hazard: Dangerous. Keep away from heat and open flame!
Explosion Hazard: Severe, when shocked or exposed to heat or flame (See Explosives, High and Section 7).

Storage and Handling: The fulminates are a group of explosives which are very sensitive to heat, impact, and friction when dry. They should be kept moist till ready for use. If compressed beyond 25,000 psi they become what is known as "dead-pressed," i.e., not capable of being exploded by flame. Fulminates are subject to deterioration when stored in hot climates. They decompose completely when they detonate and do so with great violence. They can be ignited with a flame or "spit," with a fuse, or with an electrically heated wire. They are widely used as initiators or primers for bringing about the detonation of high explosives or the ignition of powder. They are commonly used in combination with substances which provide a more prolonged blow and a bigger flame than fulminates alone. In the reinforced type of detonator, fulminates are made more effective by the addition of a more sensitive and powerful high explosive such as tetryl. This material is generally used in the manufacture of caps and detonators for initiating explosions for military, industrial, and sporting purposes. All precautions required for protection of magazines apply to storage of these materials. They should not be handled when frozen. Wet fulminate of mercury or wet floor coverings containing small quantities of fulminates may be burned on windrows of flammable material. Nonexplosive products are formed by neutralizing fulminates with cold sodium thiosulfate. All floors, tables and walls where the dry fulminates have been used should be washed with this solution.

In the manufacture of mercury fulminate, the fumes given off are toxic and flammable. Care is required to prevent fulminate dust from being carried off in the exhaust system; deposits thus made have caused explosions. Much attention should be given to cleanliness as foreign or gritty materials in the product may cause an unexpected explosion. The floors on which fulminates are used, should be covered with 1/16 inch cloth inserted rubber packing or its equal. All cracks and crevices should be covered. The walls of these rooms should be covered with glazed, water-proof material. Frequent washing with neutralizing solution is necessary. In manufacture, the fulminate is dried on muslin squares on a drying table. Drying tables may be heated with hot water or the dry house may be heated with a warm air blower system. The drying temperature should be between 50 and 60°C. Primer caps and detonators, loaded with fulminate of mercury are less sensitive than the dry bulk material but must be handled with great care anyway. Fires involving these assemblies should be treated the same as for the bulk material. They will explode as soon as fire reaches them. Stocks in an assembly or loading room should be kept as small as possible. Examples of fulminates commonly used in the explosives industry are mercury fulminate, copper fulminate and silver fulminate. See also Section 7.

FUMARIC ACID

Synonym: trans-Butenedioic acid.
Description: Colorless, odorless crystals.
Formula: HOOCCH:CHCOOH
Constants:
 Mol. Wt. 116.1
 M. P. 287°C
 B. P. 290°C subl.
 Density 1.635 @20°/4°C
Toxic Hazard Rating:
 Acute Local: Irritant 1
 Acute Systemic: Ingestion 1
 Chronic Local: U
 Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits smoke (Section 6).
Storage and Handling: Section 7

FUMARYL CHLORIDE

Synonym: trans-Butenedioyl chloride.

Description: Clear, straw-colored liquid.

Formula: $(ClOCCH)_2$

Constants:

Mol. Wt. 153
B. P. 160.0°C
Density 1.408 @20°/4°C
Toxicity: Probably high. See Hydrochloric Acid.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene and hydrochloric acid; it will react with water or steam to produce toxic and corrosive fumes.

Storage and Handling: Section 7

FURAN

Synonym: Furfurane, oxole.

Description: Water-white liquid.

Formula: C_4H_4O

Constants:

Mol. Wt. 68.07
M. P. −85.65°C
B. P. 31.36°C
Flash P. −32°F (C.C.)
Density 0.937 @20°/4°C
Vap. D. 2.35

Toxic Hazard Rating:

Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3

Caution: The exposure concentration limit of 10 ppm together with its low boiling point requires that adequate ventilation be provided in areas handling this chemical. Contact with liquid must be avoided since this chemical can be absorbed through the skin. Thorough washing with soap and water followed by prolonged rinsing should be done immediately after accidental contact.

Fire Hazard: Highly dangerous when exposed to heat or flame; can react with oxidizing materials. Unstabilized, it may form unstable peroxides on exposure to air and should always be tested before distillation. Washing with an aqueous solution of ferrous sulfate slightly acidified with sodium bisulfate will remove these peroxides, Confirm by test. Contact with acids can initiate a violent exothermic reaction.

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Moderate, when exposed to flame. The low boiling point of this material makes it easy to obtain explosive concentrations of the vapor in inadequately ventilated areas.

Explosive Range: 2.3 – 14.3%

Disaster Control: Highly dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.

Ventilation Control (use high rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

FURFURAL

Synonyms: 2-Furancarbonal; 2-furaldehyde; fural; furale.

Description: Colorless-yellow liquid; almond-like odor.

Formula: C_4H_3OCHO

Constants:

Mol. Wt. 96.1
M. P. −36.5°C
B. P. 161.7°C @764 mm
Flash P. 140°F (C.C.)
Density 1.161 @20°/20°C
Autoign. Temp. 743°F
Vap. D. 3.31

Toxic Hazard Rating:

Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Chronic Local: U
Chronic Systemic: U

MAC: ACGIH (tentative); 15 parts per million in all.

Toxicology: The liquid is dangerous to the eyes. The vapor is irritant to mucous membranes and is a central nervous system poison. However, its low volatility reduces its toxic effect. Furfural which has been ingested has produced cirrhosis of the liver in rats. In industry there is a tendency to minimize the danger of acute effects resulting from exposure to

it. This is true, particularly, because of its low volatility. Little is known concerning the possibility of chronic effects, such as nervous disturbances, following prolonged or severe exposure to this material.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame or by chemical reaction. An exothermic resinification of almost explosive violence can occur upon contact with strong mineral acids or alkalies.
Explosive Range: 2.1% @125°C
Disaster Control: Moderately dangerous. Keep away from heat and open flame!
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

FURFURYL ALCOHOL

Description: Clear, colorless, mobile liquid.
Formula: $C_4H_3OCH_2OH$
Constants:
  Mol. Wt. 98.1
  M. P. −31°C
  B. P. 171°C @750 mm
  Flash P. 167°F (O. C.)
  Density 1.129 @20°/4°C
  Autoign. Temp. 750°F
  Vap. Press. 1 mm @31.8°C
  Vap. D. 3.37
Toxicity: Details unknown. See also Alcohols.
MAC: ACGIH (tentative); 1200 parts per million in air.
Fire Hazard: Moderate, when exposed to heat; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range; 1.8 −16.3% (between 72.5° − 122°C)
Storage and Handling: Section 7

FURFURYLAMINE

Synonym: 2-Furanmethylamine.
Description: Light straw-colored liquid.
Formula: $C_4H_3OCH_2NH_2$
Constants:
  Mol. Wt. 97.1
  B. P. 146°C
  Flash P. 99°F (O. C.)
  Freezing P. −70°C
  Density 1.0502 g/cc @25°C
  Vap. D. 3.35
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

FURNITURE POLISH

Toxicity: Variable; allergen.
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Combustible liquid; inflammable liquid; red label.

FUROIC ACID

Synonym: Pyromucic acid.
Description: White solid.
Formula: $C_4H_3OCO_2H$
Constants:
  Mol. Wt. 112.1
  M. P. 133°C; sublimes @100°C
  B. P. 230° − 232°C
Toxicity: Details unknown; a bactericide.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

FUROYL CHLORIDE

Description: Colorless liquid.
Formula: C_4H_3OCOCl
Constants:
  Mol. Wt. 130.5

B. P. 176°C
M. P. −2°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene and chlorides; it will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

FURS
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: 0
  Chronic Local: Allergen 1
  Chronic Systemic: Inhalation 1
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).

FUSE IGNITERS. See Explosives, High.
Shipping Regulations: Section 11.
  I. C. C. Classification: Explosive C.
  Coast Guard Classification: Explosive C.

FUSE LIGHTERS. See Explosives, High.
Shipping Regulations: Section 11.
  I. C. C. Classification: Explosive C.
  Coast Guard Classification: Explosive C.

FUSEL OIL. See Isoamyl Alcohol, Primary.
Shipping Regulations: Section 11.
  Coast Guard Classification: Combustible liquid.

FUSES. See Explosives, High.

G

GABIAN OIL
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7

GADOLINIUM
Description: A metallic element.
Formula: Gd
Constant:
Mol. Wt. 156.90
Toxicity: Unknown

GADOLINIUM BROMIDE
Description: Rhombic plates.
Formula: $GdBr_3 \cdot 6H_2O$
Constants:
Mol. Wt. 504.74
Density 2.844 @15°C
Toxicity: See Bromides.

GADOLINIUM FLUORIDE
Description: White, gelatinous mass.
Formula: GdF_3
Constant:
Mol. Wt. 213.90
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

GADOLINIUM NITRATE
Description: Triclinic crystals.
Formula: $Gd(NO_3)_3 \cdot 5H_2O$
Constants:
Mol. Wt. 433.00
M. P. 92°C
Density 2.406 @15°C
Toxicity: See Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

GADOLINIUM OXALATE
Description: Monoclinic crystals.
Formula: $Gd_2(C_2O_4)_3 \cdot 10H_2O$
Constants: Mol. Wt. 758.02
M. P. $-6H_2O$ @110°C
Toxicity: Highly toxic. See Oxalates.

GADOLINIUM SELENATE
Description: Monoclinic, pearly crystals.
Formula: $Gd_2(SeO_4)_3 \cdot 8H_2O$
Constants:
Mol. Wt. 886.81
M. P. $-8H_2O$ @130°C
Density 3.309
Toxicity: Probably high. See Selenium and its Compounds.
Disaster Control: See Selenium and its Compounds.
Storage and Handling: Section 7

GADOLINIUM SULFIDE
Description: Yellow, hygroscopic mass.
Formula: Gd_2S_3
Constants:
Mol. Wt. 410.00
Density 3.8
Toxicity: Probably high. See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

GALENA. See Lead Compounds.

GALLIUM
Description: Silvery-white metal; forms bright, shiny liquid @30°C.
Formula: Ga
Constants:
At. Wt. 69.72
M. P. 30.0°C
B. P. 1983°C
Density Solid: 5.903 @25°C;
Liquid: 6.093 @32.38°C
Vap. Press. 1 mm @1349°C
Toxicity: See Gallium Compounds.
Radiation Hazard (Section 5): Artificial isotope Ga^{72}, half life: 14.3 hours; emits many beta particles between 0.64 - 3.2 mev, and many gamma rays between 0.84 - 2.5 mev. The permissible levels are: In body: 8 microcuries; in air: 3×10^{-6} microcurie per milliliter;

in water: 9 microcuries per milliliter.
Ventilation Control (use normal rate): Section 2

GALLIUM ACETATE, BASIC
Description: White crystals.
Formula:
$4Ga(C_2H_3O_2)_3 \cdot 2Ga_2O_3 \cdot 5H_2O$
Constants:
Mol. Wt. 1452.4
M. P. Decomposes below 100°C
Toxicity: Slight. See Gallium Compounds.

GALLIUM COMPOUNDS
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 1
Chronic Local: U
Chronic Systemic: Ingestion 1
Toxicology: Preliminary investigations show that these materials have a low order of toxicity. Work has been done with the oxide, tartrate, benzoate, and anthranilate, which were used by some investigators in the treatment of experimental syphilis. Amounts up to 15 mg/kg of body weight were injected intravenously and were tolerated without harm by laboratory animals. Larger doses produced hemorrhagic naphritis. In the case of gallium lactate, work done at the Naval Medical Research Institute showed that intravenous injections of about 40 mg of gallium per kg of body weight in rats or rabbits was lethal. Metallic gallium as well as the nitrate produced no skin injury and subcutaneous injection of relatively large amounts could be tolerated both by rabbits and rats without evidence of injury. It has, however, been demonstrated that gallium remains in the tissues for long periods of time following intramuscular injection of soluble gallium salts. Tissue distribution experiments indicate that it behaves like bismuth and mercury in that one respect.
Ventilation Control (use normal rate): Section 2

GALLIUM FERROCYANIDE
Description: Gelatinous, white material.
Formula: $Ga_4(Fe(CN)_6)_3$
Constants:
Mol. Wt. 914.8
B. P. Decomposes
Toxicity: Slight. See Ferrocyanides.
Ventilation Control (use normal rate): Section 2

GALLIUM HYDRIDE
Synonyms: Digallane; galloethane.
Description: Colorless liquid.
Formula: Ga_2H_6
Constants:
Mol. Wt. 145.49
M. P. -21.4°C
B. P. 139°C; decomp. > 130°C
Vap. Press. 2.5 mm @0. °C
Toxicity: See Hydrides.
Fire Hazard: See Hydrides.
Explosion Hazard: See Hydrides.
Disaster Control: See Hydrides.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

GALLIUM MONOSELENIDE
Synonym: Gallium selenide.
Description: Dark red-brown, greasy leaf.
Formula: GaSe
Constants:
Mol. Wt. 148.68
M. P. 960°C
Density 5.03
Toxicity: Probably toxic. See Selenium and its compounds.
Fire Hazard: Moderate, by chemical reaction which liberates hydrogen selenide.
Explosion Hazard: Slight, by chemical reaction.
Disaster Control: Moderately dangerous; when heated to decomposition it emits highly toxic fumes of selenium.
Storage and Handling: Section 7

GALLIUM MONOSULFIDE
Description: Sublimate, light yellow.
Formula: GaS
Constants:
Mol. Wt. 101.79
M. P. 956 ± 10°C
Density 3.86 @25°C
Toxicity: Probably toxic. See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.

Disaster Control: See Sulfides.
Storage and Handling: Section 7

GALLIUM MONOTELLURIDE

Description: Soft black, greasy leaves.
Formula: GaTe
Constants:
  Mol. Wt. 197.33
  M. P. 824°C
  Density 5.44
Toxicity: See Tellurium Compounds.
Fire Hazard: Moderate, by chemical reaction to liberate tellurium hydride.
Explosion Hazard: Slight, by chemical reaction.
Disaster Control: See Tellurium Compounds.
Storage and Handling: Section 7

GALLIUM NITRATE

Description: White, deliquescent crystals.
Formula: $Ga(NO_3)_3 \cdot xH_2O$
Constants:
  M. P. Decomposes @110°C
  B. P. $\longrightarrow Ga_2O_3$ @200°C
Toxicity: See Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

GALLIUM OXALATE

Description: White powder.
Formula: $Ga_2(C_2O_4)_3$
Constants:
  Mol. Wt. 403.50
  B. P. Decomposes @195°C
Toxicity: Highly toxic. See Oxalates.

GALLIUM OXYCHLORIDE

Description: Crystals.
Formula: $6GaOCl \cdot 14H_2O$
Constant:
  Mol. Wt. 979.3
Toxicity: See Gallium Compounds.
Fire Hazard: Slight; when heated, it emits toxic fumes.
Storage and Handling: Section 7

GALLIUM PERCHLORATE

Description: White, deliquescent crystals.
Formula: $Ga(ClO_4)_3 \cdot 6H_2O$
Constants:
  Mol. Wt. 476.19
  M. P. Decomposes @175°C
Toxicity: See Perchlorates.
Fire Hazard: See Perchlorates.
Explosion Hazard: See Perchlorates.
Disaster Control: See Perchlorates.
Storage and Handling: Section 7

GALLIUM SELENATE

Description: Colorless crystals.
Formula: $Ga_2(SeO_4)_3 \cdot 16H_2O$
Constant:
  Mol. Wt. 856.58
Toxicity: See Selenium Compounds.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

GALLIUM SESQUISELENIDE

Description: Reddish-black crystals.
Formula: Ga_2Se_3
Constants:
  Mol. Wt. 376.32
  M. P. 1020°C
  Density 4.92
Toxicity: See Selenium Compounds.
Fire Hazard: Moderate; it can liberate a flammable gas upon contact with moisture or acids.
Explosion Hazard: Slight; it can liberate a flammable gas upon contact with moisture or acids.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of selenium.
Storage and Handling: Section 7

GALLIUM SESQUISULFIDE

Description: Yellow crystals; white, amorphous mass.
Formula: Ga_2S_3
Constants:
  Mol. Wt. 235.64
  M. P. 1255 ± 10°C
  Density 3.65 @25°C
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

GALLIUM SESQUITELLURIDE

Description: Hard, black, brittle crystals.
Formula: Ga_2Te_3
Constants:
  Mol. Wt. 522.3
  M. P. 790°C
  Density 5.57

Toxicity: See Tellurium Compounds.
Fire Hazard: Moderate, by chemical reaction (Section 6).
Explosion Hazard: Slight, by chemical reaction.
Disaster Control: See Tellurium Compounds.
Storage and Handling: Section 7

GALLIUM SUBOXIDE
Description: Brown-black powder.
Formula: Ga_2O
Constants:
Mol. Wt. 155.44
M. P. > 660°C
Sublimes > 500°C
Density 4.77
Toxicity: See Gallium Compounds.

GALLIUM SUBSELENIDE
Description: Crystals.
Formula: Ga_2Se
Constants:
Mol. Wt. 218.40
Density 5.02
Toxicity: See Selenium Compounds.
Fire Hazard: Moderate, by chemical reaction.
Explosion Hazard: Slight, by chemical reaction.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

GALLIUM SUBSULFIDE
Description: Green crystals or black powder.
Formula: Ga_2S
Constants:
Mol. Wt. 171.51
M. P. Decomp. > 800°C
Density 4.18 @25°C
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

GALLIUM SULFATE
Description: White powder.
Formula: $Ga_2(SO_4)_3$
Constants:
Mol. Wt. 427.6
M. P. Decomp. below 600°C
Toxicity: See Gallium Compounds.

GALLIUM TRIBROMIDE
Description: Colorless, deliquescent crystals.
Formula: $GaBr_3$
Constants:
Mol. Wt. 309.47
M. P. 121.5 ± 0.6°C
B. P. 278.8°C
Density 3.69 @25°C
Toxicity: See Bromides.
Disaster Control: See Bromides.
Storage and Handling: Section 7

GALLIUM TRIFLUORIDE
Description: White powder.
Formula: GaF_3
Constants:
Mol. Wt. 126.7
M. P. > 1000°C
B. P. Sublimes approx. 950°C
Density 4.47
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

GALLIUM TRIFLUORIDE TRIAMMINE
Description: White powder.
Formula: $GaF_3 \cdot 3NH_3$
Constants: Mol. Wt. 177.82
M. P. $-NH_3$ @100°C
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

GALLIUM TRIIODIDE
Description: Colorless to lemon-yellow, hygroscopis needles.
Formula: GaI_3
Constants:
Mol. Wt. 450.48
M. P. 212 ± 1°C
B. P. 345°C sublimes
Density 4.15 @25°C
Toxicity: See Iodides.
Disaster Control: See Iodides.
Storage and Handling: Section 7

GAMBALA
Description: A wood.
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Slight, when exposed to heat or flame.

Personal Hygiene: Section 3
Storage and Handling: Section 7

GAMBOGE

Synonym: Cambogia
Toxic Hazard Rating:
  Acute Local: Ingestion 3
  Acute Systemic: Ingestion 3
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.
Personal Hygiene: Section 3

GAMMA RAYS

Description: Electromagnetic radiation emitted by certain radioactive isotopes. Gamma rays are similar to x-rays, but are more energetic and penetrating than the x-rays ordinarily used in medical diagnosis and therapy.
Radiation Hazard: See Section 5 for complete discussion.

GARBAGE TANKAGE CONTAINING LESS THAN 8% MOISTURE

Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
Explosion Hazard: Unknown
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid; yellow label.

GAS CYLINDERS, EMPTY See Shipping Regulations (Section 11).

GAS DRIPS, HYDROCARBON

Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Combustible liquid.
  Coast Guard Classification: Inflammable liquid; red label.

GAS IDENTIFICATION SETS

Shipping Regulations: Section 11.
  I. C. C. Classification: Poison A and C; poison gas label.
  Coast Guard Classification: Poison A; poison gas label.

GAS OIL

Description: Yellow liquid.
Constants:
  Flash P. 150 °F
  Density < 1
  Autoign. Temp. 640 °F
  B. P. 230 - 450 °C
Toxicity: Details unknown. See also Kerosene.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 6.0 - 13.5%
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  Coast Guard Classification: Combustible liquid.

GASOLINE

Synonym: Petrol.
Description: Clear, aromatic, volatile liquid.
Formula: A mixture of aliphatic hydrocarbons.
Constants:
  Flash P. −50 °F (C. C.)
  Density Less than 1.0
  Vap. D. 3.0 - 4.0
  Autoign. Temp. 495 °F
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1; Inhalation 1
  Acute Systemic: Inhalation 2
  Chronic Local: Irritant 1
  Chronic Systemic: Inhalation 1
MAC: ACGIH (accepted); 500 parts per million in air.
Toxicology: Occurrence of chronic poisoning is questionable. Gasoline can cause hyperemia of the conjunctiva and other disturbances of the eyes. The vapors are not considered to be very poisonous, unless its concentration in air is sufficiently high to reduce the oxygen content below that needed

to maintain life, in which case it acts as a simple asphyxiant.
Fire Hazard: Dangerous; when exposed to heat or flame; can react vigorously with oxidizing materials.
Underwriters Laboratory Classification: 95 - 100
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 1.3 - 6.0%
Disaster Control: Dangerous, in the presence of heat or flame.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Inflammable liquid; red labe.

GASOLINE (CASINGHEAD)

Description: Aromatic, volatile liquid.
Constant:
  Flash P. 0°F or less
Toxicity: See Gasoline
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials (Section 6).
Explosion Hazard: Unknown.
Disaster Control: Dangerous, in the presence of heat or flame.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

GASOLINE VAPORS. See Gasoline.

GEL COALITES. See Explosives, High.

GELSEMININE

Description: An alkaloid.
Formula: $C_{20}H_{22}N_2O_2$
Constants: Mol. Wt. 332.4
  M. P. 178°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3
  Chronic Local: U
  Chronic Systemic: U
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

GELSEMIUM

Description: A mixture of alkaloids.
Composition: Chief constituents: gelsemine, gelseminine and gelsemic acid.
Toxicity: See Gelseminine.
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

GELSEMIUM SEMPERVIRENS

Synonym: Yellow jasmine.
Toxicity: See Gelseminine.
Caution: Can seriously affect the eyes.
Storage and Handling: Section 7

GENERALS. See Explosives, High.

GERMANIUM

Description: Cubic gray-white metal.
Formula: Ge
Constants:
  At. Wt. 72.60
  M. P. 958.5°C
  B. P. 2700°C
  Density 5.35 @20°/20°C
Toxicity: See Germanium Compounds.
Radiation Hazard (Section 5): Artificial isotope Ge^{71}, half-life: 11 days. The permissible levels are: in body: 67 microcuries; in air: 4×10^{-5} microcurie per milliliter; in water: 9 microcurie per milliliter.
Fire Hazard: Moderate in the form of dust, when exposed to heat or flame. See also Powdered Metals (Section 6).
Explosion Hazard: See Powdered Metals.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

GERMANIUM COMPOUNDS

Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: Ingestion 2; Inhalation 1
Toxicology: Germanium compounds are considered to be of a low order or toxicity, but rare instances of poisoning have been reported in the literature. Interest is high in

this material because of its close chemical relationship to arsenic. It has been found that the dioxide stimulates the generation of red blood cells, but it is believed to be relatively nontoxic. When germanium is given in sublethal amounts, it causes a pronounced tolerance to be exhibited. Germanium compounds are considered much less toxic than the corresponding lead and tin compounds. Buffered germanium dioxides in solution have been found to be nonirritating to the skin. Germanium hydride is a hemolytic gas and has been shown to have toxic properties at concentration levels of 100 ppm. It can cause death in concentration of 150 ppm.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

GERMANIUM DIBROMIDE
Description: Colorless needles or plates.
Formula: $GeBr_2$
Constants:
Mol. Wt. 232.4
M. P. 122.0°C
B. P. Decomposes
Toxicity: See Bromides.
Disaster Control: See Bromides.
Storage and Handling: Section 7

GERMANIUM DICHLORIDE
Description: White powder.
Formula: $GeCl_2$
Constants:
Mol. Wt. 143.5
M. P. Decomp. to $Ge + GeCl_4$
Toxicity: See Germanium Compounds.
Fire Hazard: Slight; when heated, it emits toxic fumes.
Storage and Handling: Section 7

GERMANIUM DIFLUORIDE
Description: White, deliquescent crystals.
Formula: GeF_2
Constants:
Mol. Wt. 110.6
M. P. Decomp. > 350°C
B. P. Sublimes
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

GERMANIUM DIIODIDE
Description: Yellow, hexagonal crystals.
Formula: GeI_2
Constants:
Mol. Wt. 326.44
M. P. Sublimes and decomposes
Toxicity: See Iodides.
Disaster Control: See Iodides.
Storage and Handling: Section 7

GERMANIUM DIOXIDE (INSOLUBLE)
Description: Tetragonal crystals.
Formula: GeO_2
Constants:
Mol. Wt. 104.60
M. P. 1086 ± 5°C
Density 6.239
Toxicity: See Germanium Compounds.

GERMANIUM DIOXIDE (SOLUBLE)
Description: Hexagonal, colorless crystals.
Formula: GeO_2
Constants:
Mol. Wt. 104.60
M. P. 1115.0°C
Density 4.703 @18°C
Toxicity: See Germanium Compounds.

GERMANIUM DISULFIDE
Description: White powder; orthorhombic, white crystals.
Formula: GeS_2
Constants:
Mol. Wt. 136.73
M. P. Ca. 800°C
B. P. Sublimes > 600°C
Density 2.94 @14°C
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

GERMANIUM IMIDE
Description: White, amorphous powder.
Formula: $Ge(NH)_2$
Constants:
Mol. Wt. 102.63
M. P. Decomposes @150°C
Toxicity: Details unknown. See Germanium Compounds.

GERMANIUM MONOHYDRIDE
Description: Brown powder.
Formula: GeH

Constants:
  Mol. Wt. 73.61
  M. P. Decomposes @165°C
  B. P. May explode
Toxicity: Details unknown. See also Hydrides and Germanium Compounds.
Fire Hazard: Moderate. See also Hydrides.
Explosion Hazard: Moderate. See also Hydrides.
Disaster Control: See Hydrides.
Storage and Handling: Section 7

GERMANIUM MONOSULFIDE
Description: Yellow-red, amorphous or black crystals.
Formula: GeS
Constants:
  Mol. Wt. 104.67
  M. P. 530°C
  B. P. Sublimes > 430°C
  Density Amorphous: 3.31; rhombic: 4.01 @14°/14°C
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides
Disaster Control: See Sulfides
Storage and Handling: Section 7

GERMANIUM MONOXIDE
Description: Black, crystalline powder.
Formula: GeO
Constants:
  Mol. Wt. 88.60
  M. P. Sublimes @710°C
Toxicity: See Germanium Compounds.

GERMANIUM OXYCHLORIDE
Description: Colorless liquid.
Formula: $GeOCl_2$
Constants:
  Mol. Wt. 159.51
  M. P. -56.0°C
  B. P. Decomposes > 20°C
Toxicity: See Hydrochloric Acid.
Disaster Control: Moderately dangerous; when heated, it emits toxic fumes of chlorides.
Storage and Handling: Section 7

GERMANIUM TETRABROMIDE
Description: Gray-white crystals.
Formula: $GeBr_4$
Constants:
  Mol. Wt. 392.26
  M. P. 26.1°C
  B. P. 186.5°C
  Density 3.132 @29°/29°C
Toxicity: See Bromides.
Disaster Control: Moderately dangerous, when heated it emits toxic fumes of bromides.
Storage and Handling: Section 7

GERMANIUM TETRACHLORIDE
Description: Colorless liquid.
Formula: $GeCl_4$
Constants:
  Mol. Wt. 214.43
  M. P. -49.5°C
  B. P. 83.1°C
  Density 1.879
Toxicity: See Hydrochloric Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

GERMANIUM TETRAFLUORIDE
Description: Colorless gas or solid; not liquid at atmospheric pressure.
Formula: GeF_4
Constants:
  Mol. Wt. 148.60
  M. P. Sublimes
  Density 6.65 g/l
Toxicity: See Fluorides.
Disaster Control: Dangerous; emits highly toxic fumes of fluorides.
Storage and Handling: Section 7

GERMANIUM TETRAHYDRIDE
See Monogermane.

GERMANIUM TETRAIODIDE
Description: Cubic, yellow crystals.
Formula: GeI_4
Constants:
  Mol. Wt. 580.28
  M. P. 144.0°C
  B. P. Decomposes
  Density 4.322 @26°/26°C
Toxicity: See Iodides.
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes of iodides.
Storage and Handling: Section 7

GIN
Composition: a 40 to 50% ethyl alcohol beverage made from

juniper and coriander berries, etc.
Constants:
B. P. 82°C
Flash P. 89°F
Autoign. Temp. 799°F
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2
Chronic Local: U
Chronic Systemic: Ingestion 1
Fire Hazard: Moderate, when exposed to heat or flame; can react vigorously with oxidizing materials.
Underwriters Laboratory Classification: 70
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when heated or exposed to a flame.
Explosive Range: 3.3 - 19%
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

GINGER
Synonym: Zingiber.
Description: Irregularly bunched pieces; aromatic odor.
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1
Acute Systemic: U
Chronic Local: Irritant 1; Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

GLASS FIBER, DUST. See "Fiberglas."

GLASS WOOL. See "Fiberglas."

GLUE
Description: A collodial suspension of proteins in water; from white to brown slabs, flakes or chips.
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits smoke (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

GLYCERINE
Synonyms: 1, 2, 3-Propanetriol; glycerol.
Description: Colorless or pale yellow liquid; odorless and syrupy; sweet and warm taste.
Formula: $CH_2OHCHOHCH_2OH$
Constants:
Mol. Wt. 92.09
M. P. 17.9°C (solidifies at a much lower temperature)
B. P. 290°C
Flash P. 349°F
Density 1.260 @20°/4°C
Autoign. Temp. 739°F
Vap. Press. 0.0025 mm @50°C
Vap. D. 3.17
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1
Acute Systemic: Ingestion 1
Chronic Local: 0
Chronic Systemic: 0
Fire Hazard: Slight, when exposed to heat, flame or powerful oxidizers.
Underwriters Laboratory Classification: 10 - 20
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

GLYCEROL. See Glycerine.

GLYCEROL TRINITRATE. See Nitroglycerine.

GLYCERYL TRIACETATE
Synonym: Triacetin.
Formula: $(C_3H_5)(OOCCH_3)_3$
Constants: Mol. Wt. 218.2
M. P. -78°C
B. P. 258°C
Flash P. 280°F (C. C.)
Density 1.161
Autoign. Temp. 812°F
Vap. D. 7.52
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: Ingestion 1
Chronic Local: U
Chronic Systemic: Ingestion 1

Fire Hazard: Slight, when exposed to heat, flame or powerful oxidizers.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

GLYCERYL TRIBUTYRATE. See Tributyrin.

GLYCERYL TRINITRATE. See Nitroglycerin.

GLYCIDYL PHENYL ETHER

Description: Liquid.
Formula: $C_6H_4CH_2CHOCH_2$
Constants:
  Mol. Wt. 150.17
  M. P. 3.5°C
  B. P. 245°C
  Flash P. 175°F (O.C.)
  Density 1.1092 @20°/4°C
  Vap. D. 5.18
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

GLYCOL DIACETATE. See Ethylene Glycol Diacetate.

GLYCOL DIFORMATE

Synonym: Ethylene formate.
Description: Liquid.
Formula $HCOOCH_2CH_2OOCH$
Constants:
  Mol. Wt. 118.1
  B. P. 345°F
  Flash P. 200°F (O.C.)
  Density 1.227
  Vap. D. 4.07
Toxicity: Details unknown. See Formic Acid.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

GLYCOLIC ACID

Synonyms: Hydroxyethanoic acid; hydroxyacetic acid.
Description: Rhombic leaflets from ether.
Formula: $HOCH_2COOH$
Constants:
  Mol. Wt. 76.05
  B. P. Decomposes
  M. P. (a): 63°C; (b): 79°C
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1
  Acute Systemic: Ingestion 1
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

GLYCOLONITRILE

Synonym: Formaldehyde cyanohydrin.
Description: Mobile, colorless, odorless oil.
Formula: $HOCH_2CN$
Constants:
  Mol. Wt. 57.1
  B. P. 183°C with slight decomp.
  Freezing P. −67°C
  Density 1.104
  Vap. D. 1.97
Toxicity: Highly toxic. See Cyanides.
Explosion Hazard: Moderate, when exposed to heat or by spontaneous chemical reaction in the presence of alkalies if uninhibited (polymerizes).
Disaster Control: Highly dangerous; emits highly toxic fumes on decomposition.
Storage and Handling: Section 7

GLYCOLS

Toxicity: Dihydric alcohols are physically and chemically related to glycerol. Most of the glycols have low volatility and consequently present little danger from inhalation of vapors. Severe and even fatal poisoning has occurred following ingestion of ethylene glycol and severe occupational poisoning has been caused by ethylene glycol monomethyl ether (methyl "Cellosolve"). Under ordinary conditions of industrial use, most of the commonly used glycols are not considered to be toxic.

GLYOXAL

Synonyms: Ethanedial; oxalaldehyde; biformyl.
Description: Yellow crystal or light yellow liquid.
Formula: OCHCHO
Constants: Mol. Wt. 58.0
M. P. 15°C
B. P. 50.4°C
Density 1.14 @20°/4°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

GLYOXALIDINE DERIVATIVES

See 1-Hydroxethyl-2-heptadecylglyoxalidine.

GOLD

Description: Cubic yellow, ductile, metallic crystals.
Formula: Au
Constants: At. Wt. 197.20
M. P. 1063°C
B. P. 2966°C
Density 19.3; Liquid: 17.0 @ 1063°C
Vap. Press. 1 mm @1869°C
Toxicity: Negligible; see Gold Compounds.
Radiation Hazard (Section 5): Artificial isotope Au^{198}, half life: 2.7 days; emits beta particles of 0.97 mev and gamma rays of 0.41 mev. The permissible levels are: in body: 10 microcuries; in air: 1×10^{-7} microcurie per milliliter; in water: 3×10^{-3} microcurie per milliliter. Artificial isotope Au^{199}, half-life 3.3 days; emits beta particles of 0.32 mev and many gamma rays between 0.02 - 0.23 mev. The permissible levels are: In body: 28 microcuries; in air: 2.5×10^{-7} micorcurie per milliliter; in water: 7×10^{-3} microcuries per milliliter.

GOLD CHLORIDE

Synonym: Chlorauric acid.
Description: Claret-red prisms.
Formula: $AuCl_3$
Constants: Mol. Wt. 303.6
M. P. 254°C Decomposes
B. P. Sublimes @265°C
Density 3.9
Toxicity: See Chlorides.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes of chlorides.
Storage and Handling: Section 7

GOLD COMPOUNDS

Toxic Hazard Rating:
Acute Local: Allergen 2
Acute Systemic: Ingestion 2
Chronic Local: Allergen 2
Chronic Systemic: Ingestion 2
Inhalation 2
Toxicology: Salts of gold, particularly gold sodium thiosulfate, have been used extensively in the treatment of some forms of arthritis and for other diseases. Toxic reactions are not infrequent. Various allergic manifestations have occurred, such as urticaria, (hives) itching, purpura and other types of skin rashes, some of which may be quite severe (Section 9). Damage to the blood forming organs resulting in aplastic anemia has been described. The liver, kidneys and nervous system may be affected.

If gold therapy is being used, careful watch must be kept for the first signs of toxic reaction and the drug be promptly discontinued. BAL has been reported to be of value in treating gold poisoning.
Ventialtion Control (use normal rate): Section 2

GOLD DITELLURIDE

Description: Crystal forms: rhombic; monoclinic; triclinic.
Formula: $AuTe_2$

Constants:
Mol. Wt. 452.42
M. P. 472°C Decomposes
Density 8.2 - 9.3
Toxicity: See Tellurium Compounds and Gold Compounds.
Fire Hazard: See Hydrides.
Explosion Hazard: See Hydrides.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of tellurium; will react with water, steam or acid to produce toxic and flammable vapors of tellurium hydride.
Storage and Handling: Section 7

GOLD IODIDE

Synonym: Aurous iodide.
Description: Greenish-yellow powder.
Formula: AuI
Constants:
Mol. Wt. 324.12
M. P. 120°C Decomposes
Density 8.25
Toxicity: See Iodides.
Disaster Control: See Iodides.
Storage and Handling: Section 7

GOLD PHOSPHIDE

Description: Gray crystals.
Formula: Au_2P_3
Constants:
Mol. Wt. 487.34
M. P. Decomposes
Density 6.67
Toxicity: High. See Phosphides.
Fire Hazard: See Phosphides.
Explosion Hazard: See Phosphides.
Disaster Control: Dangerous; on decomposition it emits highly toxic fumes. (See Phosphides).
Storage and Handling: Section 7

GOLD POTASSIUM BROMIDE

Synonym: Potassium auribromide.
Description: Violet crystals.
Formula: $AuBr_3 \cdot KBr \cdot 2H_2O$
Constant:
Mol. Wt. 592.01
Toxicity: See Bromides.
Disaster Control: See Bromides.
Storage and Handling: Section 7

GOLD POTASSIUM CHLORIDE

Synonym: Potassium aurichloride.
Description: Yellow crystals.
Formula: $AuCl_3 \cdot KCl \cdot 2H_2O$
Constant:
Mol. Wt. 414.17
Toxicity: See Gold Compounds.
Disaster Control: See Chlorides.
Storage and Handling: Section 7

GOLD POTASSIUM CYANIDE

Synonyms: Potassium cyanaurite; potassium aurocyanide.
Description: White, crystalline powder.
Formula: $KAu(CN)_2 \cdot 2H_2O$
Constant:
Mol. Wt. 324.36
Toxicity: Highly toxic. See Cyanides.
Disaster Control: Dangerous; on heating to decomposition, it emits highly toxic fumes of cyanides.
Storage and Handling: Section 7

GOLD SELENIDE

Description: Solid.
Formula: Au_2Se_3
Constants:
Mol. Wt. 631.28
Density 4.65 @22°C
Toxicity: See Selenium Compounds.
Fire Hazard: Moderate, by chemical reaction with moisture or acids.
Explosion Hazard: Slight. See Hydrogen Selenide.
Disaster Control: Dangerous; when heated, it emits highly toxic fumes of selenium; will react with water, steam, or acid to produce toxic and flammable vapors of hydrogen selenide.
Storage and Handling: Section 7

GOLD SODIUM BROMIDE

Synonym: Sodium auribromide.
Description: Black-brown crystals.
Formula: $AuBr_3 \cdot NaBr \cdot 2H_2O$
Constant:
Mol. Wt. 575.91
Toxicity: See Bromides.
Disaster Control: See Bromides.
Storage and Handling: Section 7

GOLD SODIUM CHLORIDE

Synonyms: Sodium aurichloride; sodium chloraurate.
Description: Yellow crystals.
Formula: $NaAuCl_4 \cdot 2H_2O$
Constant: Mol. Wt. 398.05
Toxicity: See Gold Compounds

GOLD SODIUM THIOSULFATE

Synonym: Aurous sodium thiosulfate.

Description: White crystals, odorless.
Formula: $Na_3Au(S_2O_3)_2 \cdot 2H_2O$
Constant:
Mol. Wt. 527.47
Toxicity: See Gold Compounds.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

GOLD TELLURIDE

Description: Triclinic crystals.
Formula: Au_2Te
Constants:
Mol. Wt. 522.0
Density 9.04
Toxicity: See Tellurium Compounds.
Fire Hazard: Moderate, on contact with moisture (Section 6).
Explosion Hazard: Slight, upon contact with moisture.
Disaster Control: Moderately dangerous in a disaster because, when heated to decomposition, it emits toxic fumes of tellurium; on contact with water, steam or acid, it can emit toxic and flammable fumes of hydrogen telluride.
Storage and Handling: Section 7

GOLD TRIBROMIDE

Description: Gray powder, crystalline brown.
Formula: $AuBr_3$
Constants:
Mol. Wt. 437.0
M. P. $-Br_2$ @160°C
Toxicity: See Bromides.
Disaster Control: See Bromides.
Storage and Handling: Section 7

GRAIN SMUTS

Description: These are minute, threadlike, parasitic plants, the mycelium of which enters the growing portion of the seedling and grow up with the host. They remain invisible until the heads of grain appear, at which time they partially or wholly destroy the heads, appearing at that stage as masses of dark substance. These masses contain spores which further propagate by getting on or into the seeds where they reenact their life after the seed is planted.
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1; Inhalation 1
Chronic Systemic: Inhalation 1
Toxicology: Due to these smut spores, contact dermatitis, an atopic form of skin allergy, perennial rhinitis, and asthma may occur in those exposed. These conditions may be fairly abundant wherever favorable climate for infestation exists, which can be in the Middle West, the Pacific Northwest, the South, and the Southwest.
Personal Hygiene: Section 3

GRANITE DUST

Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: Inhalation 2
Chronic Local: Inhalation 3
Chronic Systemic: 0
Ventilation Control (use normal rate): Section 2

GRAPHITE

Synonyms: Black lead; plumbago.
Description: A crystalline form of carbon; soft, greasy feel; steel-gray to black color.
Formula: C
Constants:
At. Wt. 12.0
Density 2.0 - 2.25
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Personal Hygiene: Section 3

GRASSELLIS. See Explosives, High.

GREEK FIRE. See Explosives, Low.
Description: Essentially, this is a mixture of nitrates and pitch, which has been in use since the 8th century. This material is a deflagrating mixture and therefore properly belongs in the class of low explosives.

GREEN VITRIOL. See Ferrous Sulfate.

GRENADES (ALL TYPES). See Explosives, High.

GRIGNARD REAGENTS

Since all Grignard reagents react rapidly with both water and oxygen, contact with these substances must be avoided. So far as is known the ordinary materials of construction are satisfactory for use with Grignard reagents. Adequate ventilation should, of course, be employed.

Because the heat or decomposition of Grignard Reagents with water is great and the ether it is dissolved in is highly volatile and flammable, they must be handled with extreme care. Some of these reagents, especially the solution of MeMgBr in ethyl ether, may ignite spontaneously on contact with water or even damp floors; nearly all of these compounds will ignite on a wet rag or similar material.

All possible precautions should be taken to eliminate spills, or to curb them if they should occur.

1. Check all drums before use to see that there have been no leaks or damage to the drums. Outdoor storage in a roofed-over area protected from the weather is recommended for all Grignard reagents except phenyl magnesium bromide.

2. Any area where Grignard reagents are to be handled must be well ventilated and free from sources of ignition. All electrical fixtures and wiring must be explosion-proof, Class I Group D, or Class II Group G.

3. Prepare an area where the drums are to be opened that is completely dry, and far away from any possible water splashes. A curbed area or one surrounded by a dry sand dike is recommended for this purpose.

4. All facilities to which the reagent is being transferred should be checked to see that they are completely dry. A supply of dry sand should be close at hand.

5. Connect a solid outlet line to the drum, seeing that all joints are tight and that the outlet bung is free flowing. The inlet bung (also free) should be connected to a source of oil-pumped dry nitrogen, and about 1 to 2 psi. should be applied to the drum when pumping starts.

6. Pump the reagent out of the drums into the reactors through a closed system, using a positive displacement pump, replacing the volume with dry, oil-pumped nitrogen. Do not apply over 5 lbs. nitrogen pressure to the drum.

7. In case of a spill the material should be curbed and covered with dry sand and immediately removed. Should a large spill occur that cannot be taken up with sand, a film of decomposed Grignard will appear on the top of the material. Do not break this film any more than absolutely necessary! By means of a vacuum line or pump remove the spilled reagent to a dry container, and then remove the residue with dry sand.

8. Any solid remaining in the drums is extremely hazardous in contact with air or moisture because it may give off great quantities of heat, and may ignite any solvent remaining with it.

9. Do not attempt to wash drums out with water. It should not be necessary if nitrogen displacement has been complete. If washing is necessary, use butyl ether followed by alcohol.

GUAIACOL

Synonym: Methyl catechol.
Description: Clear, pale yellow liquid or solid.
Formula: $OHC_6H_4OCH_3$
Constants:
  Mol. Wt. 124.1
  M. P. 28°C
  B. P. 202 - 209°C
  Flash P. 180°F (O.C.)
  Density 1.097 @25°/25°C
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1; Inhalation 1
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2

Personal Hygiene: Section 3
Storage and Handling: Section 7

GUAIACOL VALERATE

Description: Oily, pale yellow liquid.
Formula: $C_6H_4OCH_3OCOC_4H_9$
Constants:
Mol. Wt. 208.3
B. P. 265°C
Density 1.05
Toxicity: Details unknown. See also Guaiacol and Valerian.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

GUANIDINE CARBONATE

Description: Columnar crystals.
Formula: $[H_2NC(NH)NH_2]_2H_2CO_3$
Constants: Mol. Wt. 180.2
M. P. 333°C
Density 1.24
Toxicity: Unknown
Disaster Control: Moderate; when heated to decomposition it emits toxic fumes.
Storage and Handling: Section 7

GUANIDINE HYDROCHLORIDE

Description: White powder.
Formula: $H_2NC(NH)NH_2 \cdot HCl$
Constants:
Mol. Wt. 95.6
M. P. 183°C
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of hydrochloric acid.
Storage and Handling: Section 7

GUANIDINE NITRATE

Description: White granules.
Formula: $H_2NC(NH)NH_2 \cdot HNO_3$
Constants: Mol. Wt. 122.1
M. P. 214°C
Toxicity: See Nitrates.
Fire Hazard: See Nitrates.
Explosion Hazard: Moderate, when shocked or exposed to heat or flame; a stable, flashless, nonhygroscopic high explosive used as a blasting explosive in combination with charcoal and inorganic nitrates.
Disaster Control: Dangerous; keep away from heat and open flame.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material.

GUANYL UREA NITRATE

Description: Crystals.
Formula: $NH_2C(NH)NHCONH_2 \cdot HNO_3$
Constants:
Mol. Wt. 165.1
M. P. > 230°C
Density 1.579 @30°C
Toxicity: See Nitrates.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: Dangerous; keep away from heat and open flame.
Storage and Handling: Section 7

GUANYL UREA PHOSPHATE

Description: Crystals.
Formula:
$NH_2C(NH)NHCONH_2 \cdot H_3PO_4$
Constants:
Mol. Wt. 200.1
M. P. 184°C Decomposes
Density 1.614
Toxicity: Unknown
Disaster Control: See Phosphorus Compounds.
Storage and Handling: Section 7

GUANYL UREA SULFATE

Description: White powder.
Formula:
$NH_2C(NH)NHCONH_2 \cdot H_2SO_4$
Constants:
Mol. Wt. 302.28
M. P. 192°C Decomposes
Density 1.609
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

GUM ARABIC. See Acacia.

GUNPOWDER. See Explosives, High.

H

HAFNIUM

Description: Gray crystals.
Formula: Hf
Constants:
- At. Wt. 178.60
- M. P. 2207°C
- B. P. < 3200°C
- Density 13.3

Toxicity: Unknown
Radiation Hazard (Section 5): Artificial isotope Hf^{181}, half-life: 47 days; emits beta particles of 0.41 mev and many gamma rays between 0.09 - 0.48 mev.

HAFNIUM CARBIDE

Description: Solid.
Formula: HfC
Constants:
- Mol. Wt. 190.61
- M. P. 3887°C

Toxicity: Unknown
Fire Hazard: Slight; will react with water or steam to produce flammable vapors (Section 6).
Storage and Handling: Section 7

HAFNIUM OXIDE

Synonyms: Hafnium dioxide; hafnia.
Description: White crystals.
Formula: HfO_2
Constants:
- Mol. Wt. 210.60
- M. P. 2810°C
- Density 9.68

Toxicity: Unknown

HAFNIUM OXYCHLORIDE

Description: Colorless crystals.
Formula: $HfOCl_2 \cdot 8H_2O$
Constant:
- Mol. Wt. 409.6

Toxicity: Details unknown. See also Hydrochloric Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of chlorides.
Storage and Handling: Section 7

HAIR

Toxic Hazard Rating:
- Acute Local: Allergen 1
- Acute Systemic: U
- Chronic Local: Allergen 1
- Chronic Systemic: U

Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
- Coast Guard Classification: (Wet) Inflammable solid; yellow label.

HAT GLAZING LACQUER

Toxicity: Details unknown. See also Lacquers.
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7

HAY

Synonym: Dried grass.
Description: Yellow, fibrous material.
Toxic Hazard Rating:
- Acute Local: Allergen 1; Inhalation 1
- Acute Systemic: 0
- Chronic Local: Allergen 1; Inhalation 1
- Chronic Systemic: 0

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Spontaneous Heating: Occurs when wet or improperly packed.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
- Coast Guard Classification: Hazardous article.

HELIUM

Description: Colorless, odorless, tasteless, inert gas.
Formula: He
Constants:
  At. Wt. 4.003
  M. P. −272.2°C @26 atm.
  B. P. −268.9°C
  Density 0.1785 g/l @0°C; 0.147 @−270.8°C (lq)
Toxicity: See Argon.
Disaster Control: Slightly dangerous; shock can shatter its compressed gas container with explosive force.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Nonflammable gas; green label.
  Coast Guard Classification: Noninflammable gas; green gas label.

HELIUM-OXYGEN MIXTURE. See Helium and Oxygen.
Shipping Regulations: Section 11.
  I.C.C. Classification: Nonflammable gas; green label.
  Coast Guard Classification: Noninflammable gas; green gas label.

HELLEBORE, BLACK. See Helleborein.

HELLEBOREIN

Description: Glucoside crystallizable in yellow prisms.
Formula: $C_{37}H_{56}O_{18}$
Constants:
  Mol. Wt. 788.63
  M. P. 270°C
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes. (Section 6).
Ventilation Control (use normal rate). Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

HELLEBORIN

Description: Colorless, lustrous crystals.
Formula: $C_{28}H_{36}O_6$
Constants:
  Mol. Wt. 468.6
  M. P. Above 250°C
Toxicity: Details unknown. See also Helleborein.
Fire Hazard: Slight; when heated, it emits acrid fumes. (Section 6).
Storage and Handling: Section 7

HELVELLIC ACID

Toxic Hazard Rating:
  Acute Local: Irritant 2
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: U
Toxicology: This is a poisonous material and a powerful hemolytic agent. It can cause superificial punctate keratitis. The symptom of poisoning from this material usually occur within the first few hours after ingestion and consist of nausea, vomiting, gastric pains, and diarrhea. Further, there is stupor, dilation of the pupils, enlargement of the liver and spleen, and tubular damage to the kidneys with albuminuria. In some cases death may follow from an acute yellow atrophy of the liver. In the absence of this last symptom, the prognosis is favorable.
Treatment and Antidotes: Injections of glucose to protect the liver can be given.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

HEMP

Toxic Hazard Rating:
  Acute Local: Allergen 1; Inhalation 1
  Acute Systemic: Inhalation 1
  Chronic Local: Allergen 1
  Chronic Systemic: Inhalation 1
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Personal Hygiene: Section 3

Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification:
Hazardous article.

HEPTACHLOROPROPANE
Formula: C_3HCl_7
Constant:
Mol. Wt. 285.3
Toxicity: Details unknown. See also Chlorinated Hydrocarbons, Aliphatic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene.
Storage and Handling: Section 7

HEPTADECANOL
Synonym: Heptadecyl alcohol.
Formula: $C_{17}H_{35}OH$
Constants:
Mol. Wt. 256.46
M. P. 130°F
B. P. 309°C
Flash P. 310°F (C.O.C.)
Density 0.8475 @20°/20°C
Vap. Press. < 0.01 mm @20°C
Vap. D. 8.84
Toxicity: Details unknown. See also Alcohols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2-HEPTADECYL GLYOXALDINE ACETATE
Synonym: Glyodin.
Description: Crystals.
Formula:
$C_{17}H_{35}\underline{CNCH_2CH_2NH} \cdot CH_3COOH$
Constant:
Mol. Wt. 368.59
Toxicity: Details unknown, but may cause irritation of eyes and skin.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7
Shipping Regulations: Section 11.
MCA warning label.

2-HEPTADECYLIMIDAZOLINE
Synonym: 2-Heptadecylglyoxalidine.
Description: Waxy solid.
Formula: $C_{20}H_{40}N_2$
Constants:
Mol. Wt. 308.54
M. P. 85°C
B. P. 200°C @2 mm
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-HEPTADECYL-2-IMIDAZOLINE ACETATE
Description: Light orange crystals.
Formula: $C_{22}H_{44}N_2O_2$
Constant:
Mol. Wt. 368.6
Toxicity: Unknown
Fire Hazard: Slight; when heated, it emits toxic fumes (Section 6).
Storage and Handling: Section 7

HEPTAFLUOROBUTYRIC ACID
Description: Colorless liquid; sharp odor similar to butyric acid.
Formula: $CF_3CF_2CF_2OOH$
Constants:
Mol. Wt. 214.00
B. P. 210.0°C @735 mm
Toxicity: Details unknown. See also Fluorides.
MAC: ACGIH (accepted); 2.5 milligrams per cubic meter of air.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides; will react with water or steam to produce corrosive fumes.
Storage and Handling: Section 7

HEPTANE
Synonyms: Heptyl hydride; dipropyl methane.
Description: Colorless liquid.
Formula: $CH_3(CH_2)_5CH_3$
Constants:
Mol. Wt. 100.20
B. P. 98.52°C
Freezing P. −90.5°C
Flash P. 25°F (C.C.)
Density 0.684 @20°/4°C
Autoign. Temp. 452°F
Vap. Press. 40 mm @22.3°C
Vap. D. 3.45

Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Inhalation 1
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (accepted); 500 parts per million in air; 2045 milligrams per cubic meter of air.
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 1.2 - 6.7%
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

1- HEPTANOL

Synonym: Heptyl alcohol.
Description: Liquid.
Formula: $C_7H_{15}OH$
Constants: Mol. Wt. 116.2
M. P. -34.6 °C
B. P. 175.8 °C
Density 0.824 @ 20°/4 °C
Toxicity: See Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-HEPTANOL

Synonym: Amyl methyl carbinol.
Description: Liquid.
Formula: $CH_3(OH)CH(CH_2)_4CH_3$
Constants:
Mol. Wt. 116.2
B. P. 160.4 °C
Flash P. 160 °F (O.C.)
Density 0.8344 @ 0 °C
Vap. Press. 1 mm @ 14.6 °C
Vap. D. 4.01
Toxicity: See Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

3-HEPTANOL

Description: Liquid.
Formula: $CH_3CH_2CH(OH)C_4H_9$
Constants:
Mol. Wt. 116.2
B. P. 156.2 °C
Flash P. 140 °F (C.O.C.)
Freezing P. -70 °C
Density 0.8224 @ 20°/20 °C
Vap. Press. 0.5 mm @ 20 °C
Vap. D. 4.01
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-HEPTANONE

Synonym: Methyl amyl ketone.
Description: Liquid; fruity odor.
Formula: $C_7H_{14}O$
Constants:
Mol. Wt. 114.2
B. P. 150.2 °C
Flash P. 106 °F
Density 0.8197 @ 15°/4 °C
Vap. Press. 1 mm @ 19.3 °C
Toxicity: See Ketones.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-HEPTENE
Description: Clear liquid.
Formula: C_7H_{14}
Constants: Mol. Wt. 98.18
B. P. 98.2°C
Flash P. < 30°F
Density 0.709 @20°/4°C
Vap. D. 3.4
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 1; Inhalation 1
Chronic Local: Irritant 1
Chronic Systemic: U
Fire Hazard: Dangerous; when exposed to heat or flame (Section 6).
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

3-HEPTENE (Mixture of cis and trans isomers)
Synonym: 1-Ethyl-2-propyl ethylene.
Description: Liquid.
Formula: $CH_3CH_2CHCHCH_2CH_2CH_3$
Constants: Mol. Wt. 98.18
B. P. 96°C
Flash P. < 20°F
Density 0.705 @15.5°/25.5°C
Vap. D. 3.38
Toxicity: Unknown
Fire Hazard: Dangerous; when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous, upon exposure to heat or flame.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

HEPTYL ALCOHOL. See 1-Heptanol.

HEXAANTIPYRINECERIUM III PERCHLORATE
Description: Colorless, hexagonal crystals.
Formula: $[Ce(C_{11}H_{12}N_2O)_6] \cdot (ClO_4)_3$
Constants: Mol. Wt. 1567.83
M. P. 295 - 300°C Decomposes
Toxicity: Details unknown. See Perchlorates.
Fire Hazard: See Perchlorates.
Explosion Hazard: See Perchlorates.
Disaster Control: See Perchlorates.
Storage and Handling: Section 7

HEXABORANE
Synonyms: Boron hydride; hexaboron decahydride.
Description: Colorless liquid, turns yellow on standing.
Formula: B_6H_{10}
Constants:
B. P. 0°C @7.2 mm
Mol. Wt. 75.0
M. P. −65.1°C
Density 0.69 @0°C
Vap. Press. 7.2 mm @0°C
Vap. D. 2.6
Toxicity: See Boron Hydride.
Fire Hazard: Dangerous, when exposed to heat or flame. See also Hydrides.
Explosion Hazard: See Hydrides.
Disaster Control: See Hydrides.
Storage and Handling: Section 7

HEXABROMOETHANE
Description: Yellowish-white, rhombic needles.
Formula: C_2Br_6
Constants: Mol. Wt. 503.5
M. P. 148°C Decomposes
B. P. 210°C Decomposes
Toxicity: See Bromine.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromides.
Storage and Handling: Section 7

gamma-**HEXACHLORIDE.** See Benzene Hexachloride.

HEXACHLOROACETONE
Description: Colorless liquid.
Formula: CCl_3COCCl_3
Constants: Mol. Wt. 264.8
B. P. 202 - 204°C
Freezing P. −2°C
Vap. D. 9.2
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangeorous; when heated to decomposition, it emits highly toxic fumes of phosgene.
Ventilation Control (use normal rate):

Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

HEXACHLOROBENZENE

Synonym: Perchlorobenzene.
Description: Monoclinic prisms.
Formula: C_6Cl_6
Constants:
  Mol. Wt. 284.80
  M. P. 230°C
  B. P. 326°C
  Flash P. 468°F
  Density 1.5
  Vap. Press. 1 mm @114.4°C
  Vap. D. 9.8
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: Ingestion 3; Inhalation 3
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

HEXACHLOROCYCLOHEXANE

See Benzene Hexachloride.

HEXACHLOROCYCLOPENTADIENE

Description: Yellow to amber-colored liquid; pungent odor.
Formula: C_5Cl_6
Constants:
  Mol. Wt. 272.79
  M. P. -2°C
  B. P. 236°C
  Density 1.715 @15.5°/15.5°C
  Vap. D. 9.42
Toxicity: Details unknown. See also Chlorinated Hydrocarbons.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

HEXACHLORODIPHENYL OXIDE

Description: Light yellow, very viscous liquid.
Formula: $C_{12}H_4Cl_6O$
Constants:
  Mol. Wt. 376.9
  B. P. 230 - 260°C @8 mm
  Density 1.60 @20°/60°C
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

HEXACHLOROETHANE

Synonyms: Carbon trichloride; carbon hexachloride.
Description: Rhombic, triclinic or cubic crystals; colorless; camphor-like odor.
Formula: CCl_3CCl_3
Constants: Mol. Wt. 236.76
  M. P. 186.6°C (Sublimes)
  Density 2.091
  Vap. Press. 1 mm @32.7°C
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2
  Acute Systemic: Ingestion 2
  Chronic Local: U
  Chronic Systemic: Ingestion 2; Inhalation 2
Explosion Hazard: Slight, by spontaneous chemical reaction. Dehalogenation of this material by reaction with alkalies, metals, etc., will produce spontaneously explosive chloroacetylenes.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

HEXACHLOROMETHYLCARBONATE

Synonym: Triphosgene.
Description: White crystals.
Formula: $(OCCl_3)_2CO$
Constants:
  Mol. Wt. 296.77
  M. P. 78 - 79°C

B. P. 205 - 206°C (partial decomposition)
Density 2 (approx.)
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Inhalation 3
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

HEXACHLOROMETHYL ETHER

Description: Liquid.
Formula: $O(CCl_3)_2$
Constants:
Mol. Wt. 252.76
B. P. 98°C (partial decomp.)
Density 1.538 @18°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

HEXACHLORONAPHTHALENE

Description: White solid.
Formula: $C_{10}H_2Cl_6$
Constant:
Mol. Wt. 334.9
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Irritant 3
Chronic Systemic: Ingestion 3; Inhalation 3
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

HEXACHLOROPROPENE

Formula: C_3Cl_6
Constant:
Mol. Wt. 248.8
Toxicity: Details unknown. See also Chlorinated Hydrocarbons.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

HEXADECANOL. See Cetyl Alcohol.

1-HEXADECINE

Synonym: 1-Hexadecyne.
Description: Liquid or crystals.
Formula: $CH_3(CH_2)_{13}C\vdots CH$
Constants:
Mol. Wt. 222.40
M. P. 15°C
B. P. 274.0°C
Density 0.797 @20°C
Vap. Press. 1 mm @101.6°C
Vap. D. 7.68
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

HEXAETHYL BENZENE

Description: Colorless crystals.
Formula: $C_6(C_2H_5)_6$
Constants:
Mol. Wt. 246.42
M. P. 130°C
B. P. 298°C
Density 0.831 @130°C
Vap. Press. 10 mm @150.3°C
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Storage and Handling: Section 7

HEXAETHYLENE GLYCOL

Description: Liquid.
Formula: $(OH)_2(CH_2)_{12}O_5$
Constant: Mol. Wt. 282.3

Toxicity: Details unknown. See also Glycols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Storage and Handling: Section 7

HEXAETHYL TETRAPHOSPHATE
Synonyms: Ethyl tetraphosphate; HETP.
Description: Liquid.
Formula: $(C_2H_5O)_6P_4O_7$
Constants:
Mol. Wt. 506.4
M. P. -40°C
B. P. Decomp. above 150°C
Density 1.2917 @27°/4°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: U
Disaster Control: See Phosphates.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Poison B; poison label.

HEXAETHYL TETRAPHOSPHATE AND COMPRESSED GAS MIXTURES
Shipping Regulations: Section 11.
I.C.C. Classification: Poison A; poison gas label.
Coast Guard Classification: Poison A; poison gas label.

HEXAFLUOROPHOSPHORIC ACID
Description: Corrosive, colorless, clear liquid.
Formula: HPF_6
Constants:
Mol. Wt. 145.99
M. P. 31°C
Density 1.65
Toxicity: Highly toxic. See Fluorides, Hydrofluoric Acid and Phosphoric Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides and oxides of phosphorus.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

HEXAHYDROPHENOL. See Cyclohexanol.

HEXAHYDROPHTHALIC ANHYDRIDE
Description: Clear, colorless, viscous liquid.
Formula: $C_6H_8(CO)_2O$
Constants:
Mol. Wt. 154.1
B. P. 158°C @17 mm
M. P. 35 - 36°C
Vap. D. 5.31
Toxicity: Details unknown. See also Phthalic Anhydride.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

n-HEXALDEHYDE
Description: Liquid.
Formula: $C_5H_{11}CHO$
Constants: Mol. Wt. 100.16
M. P. -56.3°C
B. P. 128.7°C
Flash P. 90°F (O.C.)
Density 0.8156 @20°/20°C
Vap. Press. 8.6 mm @20°C
Vap. D. 3.45
Toxicity: Details unknown. See also Aldehydes.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventialtion Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Combustible liquid.

HEXAMETHYLDISILOXANE
Formula: $Si_2O(CH_3)_6$
Constants: Mol. Wt. 162.32

B. P. 99.5°C
Flash P. 30°F
Density 0.7606 @25°/25°C
Vap. Press. 40 mm @26.7°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

HEXAMETHYLENEDIAMINE

Synonym: 1,6-Hexanediamine.
Description: Colorless, silk leaf.
Formula: $NH_2(CH_2)_6NH_2$
Constants:
Mol. Wt. 116.21
M. P. 42°C
B. P. 205°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

HEXAMETHYLENE GLYCOL. See Hexanediol-1,6

HEXAMETHYLENETETRAMINE

Synonyms: Methenamine; formamine; hexamine; urotropin.
Description: Odorless, rhombic crystals from alcohol.
Formula: $(CH_2)_6N_4$
Constants:
Mol. Wt. 140.19
M. P. Chars @280°C
B. P. 263°C Decomposes
Flash P. 482°F
Density 1.270 @25°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2
Acute Systemic: Ingestion 2
Chronic Local: Irritant 1
Chronic Systemic: Ingestion 1
Toxicology: Some persons suffer a skin rash if they come in contact with this material or the fumes evolved when it is heated (Section 9). Pure hexamethylenetetramine may be taken internally in small amounts and is used in medicine as a urinary antiseptic. Its major industrial use is in the manufacture of phenolic resins. It is combustible and can be readily ignited when a flame is applied directly to its surface. It liberates formaldehyde on decomposition.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

HEXAMETHYLPHOSPHORAMIDE

Description: Clear, colorless, mobile liquid; spicy odor.
Formula: $[(CH_3)_2N]_3PO$
Constants:
Mol. Wt. 179.2
B. P. 98 - 100°C @6 mm
Freezing P. 4°C
Density 1.024 @25°/25°C
Vap. D. 6.18
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosphorus.
Storage and Handling: Section 7

HEXAMMINECHROMIUM III CHLORIDE

Description: Yellow crystals.
Formula:
$[Cr(NH_3)_6]Cl_3 \cdot H_2O$

Constants:
Mol. Wt. 278.59
Density 1.585
Toxicity: See Chromium Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

HEXAMMINENICKEL (II) NITRATE

Description: Cubic, blue crystals.
Formula: $[Ni(NH_3)_6](NO_3)_2$
Constant:
Mol. Wt. 284.90
Toxicity: See Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

n-HEXANE

Synonym: Hexyl hydride.
Description: Colorless liquid.
Formula: $CH_3(CH_2)_4CH_3$
Constants:
Mol. Wt. 86.17
B. P. 68.7°C
Freezing P. −95.6°C
Flash P. < −10°F
Density 0.6603 @ 20°/4°C
Autoign. Temp. 500°F
Vap. Press. 100 mm @15.8°C
Vap. D. 2.97
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: Ingestion 1; Inhalation 1
Chronic Local: Irritant 1
Chronic Systemic: U
MAC: ACGIH (accepted); 500 parts per million in air; 1760 milligrams per cubic meter of air.
Fire Hazard: Dangerous, when exposed to heat or flame.
Underwriters Laboratory Classification: 90 - 95
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 1.2 - 6.9%
Disaster Control: Dangerous; when heated or exposed to flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

HEXANEDIOL-1, 6

Synonyms: 1, 6-Dihydroxyhexane; hexamethylene glycol.
Description: Clear liquid.
Formula:
$CH_3CH(OH)CH_2CH_2CH(OH)CH_3$
Constants: Mol. Wt. 118.2
M. P. 42°C
B. P. 250°C
Flash P. 205°F
Density 0.967 @0°/4°C
Vap. D. 4.07
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

HEXANEDIOL-2, 5

Description: Liquid.
Formula:
$CH_3CH(OH)CH_2CH_2CH(OH)CH_3$
Constants:
Mol. Wt. 118.17
B. P. 220.8°C
Flash P. 220°F (O.C.)
Density 0.9617 @20°/20°C
Vap. D. 4.07
Toxicity: Details unknown. See also Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

HEXANEDIONE-2, 5. See Acetonyl Acetone.

HEXANETRIOL-1, 2, 6

Description: Colorless liquid.
Formula:
$HOCH_2CH(OH)(CH_2)_3CH_2OH$
Constants:
Mol. Wt. 134.17
B. P. 178°C @5 mm

Freezing P. −20°C
Flash P. 380°F (C.O.C.)
Density 1.1063 @20°/20°C
Vap. Press. < 0.01 mm @20°C
Vap. D. 4.63
Toxicity: Details unknown. See also Alcohols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Storage and Handling: Section 7

HEXANITRODIPHENYLAMINE
Synonyms: Hexil; hexite; hexamine.
Toxicity: Details unknown. See also Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates. A powerful and violent explosive used as a booster explosive, in which use it is superior to TNT. It is not as good for this purpose as tetryl, but is extremely stable and much safer to handle.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

HEXANITRODIPHENYLAMINOETHYL NITRATE
Toxicity: Details unknown. See also Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates. This explosive is slightly less sensitive to impact than tetryl, but equally sensitive to detonation by other means. It is considered about as powerful as tetryl. Its explosive strength can be enhanced by addition of oxygen-rich salts, such as potassium chlorate. It may replace tetryl as a booster as well as in detonating compositions.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

HEXANITRODIPHENYLOXIDE
Toxicity: Details unknown. See also Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates. This high explosive is stable and not very sensitive. It is used in detonating compositions and is considered more powerful than picric acid. See also Explosives, High.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

HEXANITRODIPHENYL SULFIDE
Synonym: Picryl sulfide.
Toxicity: See Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates. This material is a powerful explosive and has an added military advantage in that its explosion gases contain irritating and very toxic sulfur dioxide. See also Explosives, High.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

HEXANITRODIPHENYL SULFONE
Toxicity: Details unknown. See also Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates. This material is a stable, very powerful high explosive, used in detonating compositions. See also Explosives, High.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

HEXANITROMANNITOL. See Mannitol Hexanitrate.

HEXANITROOXANILITE
Toxicity: Details unknown. See also Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates. This material is about as powerful an explosive as TNT. See also Explosives, High.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

1-HEXANOL
Synonyms: n-Hexyl alcohol; amylcarbinol.
Description: Colorless liquid.
Formula: $CH_3(CH_2)_4CH_2OH$
Constants:
Mol. Wt. 102.2
B. P. 157.2°C
Freezing P. −44.6°C
Flash P. 165°F (C.O.C.)
Density 0.8186 @20°/4°C
Vap. Press. 1 mm @24.4°C
Vap. D. 3.52

Toxicity: See Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2-HEXANONE. See Methyl n-Butyl Ketone.

3-HEXANONE

Synonym: Ethyl propyl ketone.
Description: Colorless liquid.
Formula: $C_2H_5CO(CH_2)_2CH_3$
Constants:
  Mol. Wt. 100.16
  B. P. 124°C
  Density 0.813 @21.8°/4°C
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: Inhalation 2
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

HEXENE-1

Synonyms: Hexene; butylethylene; hexylene.
Description: Colorless liquid.
Formula: $CH_2CH(CH_2)_3CH_3$
Constants:
  Mol. Wt. 84.16
  M. P. −98.5°C
  B. P. 63.5°C
  Freezing P. −139.9°C
  Flash P. < 20°F
  Density 0.6732 @20°/4°C
  Vap. Press. 310 mm @38°C
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: Inhalation 2
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Dangerous; when exposed to heat or flame (Section 6).
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

HEXENE-2

Description: A liquid.
Formula: C_6H_{12}
Constants:
  Mol. Wt. 84.16
  B. P. 68.5°C
  Flash P. < 20°F
  Density 0.686 @15.5°/15.5°C
  Vap. D. 2.92
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

HEXONE

Synonyms: 4-Methyl-2-pentanone; methyl isobutyl ketone.
Description: Colorless liquid.
Formula: $CH_3COCH_2CH(CH_3)_2$
Constants:
  Mol. Wt. 100.16
  M. P. −84.7°C
  B. P. 119°C
  Flash P. 74°F
  Density 0.8017 @20°/4°C
  Vap. D. 3.45
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: Inhalation 2
  Chronic Local: U
  Chronic Systemic: U
MAC: ACGIH (accepted); 100 parts per million in air; 409 milligrams per cubic meter of air.
Toxicology: This material is toxic and has a distinct and irritating

odor at concentrations below the flammable range. This should attract immediate attention, and the warning should be heeded.
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

sec-**HEXYL ACETATE.** See Methyl Amyl Acetate.

HEXYL ALCOHOL. See Hexanol.

n-**HEXYL AMINE**
Description: Liquid.
Formula: $C_6H_{13}NH_2$
Constants:
Mol. Wt. 101.19
M. P. −22.9°C
B. P. 131.4°C
Flash P. 85°F (O.C.)
Density 0.7675 @20°/20°C
Vap. D. 3.49
Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

N, n-**HEXYL-2-AMINOHEPTANE**
Synonym: N-N-Hexyl-n-heptylamine.
Description: Crystals.
Formula: $C_6H_{13}NHCH_3CHC_5H_{11}$
Constant:
Mol. Wt. 199.4
Toxicity: Details unknown. See also Amines.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

n-**HEXYL "CARBITOL"**
Description: Liquid.
Formula: $C_6H_{13}O(C_2H_4O)_2H$
Constants:
Mol. Wt. 190.03
B. P. 258.2°C
Freezing P. −33.3°C
Flash P. 285°F (O.C.)
Density 0.9346 @20°/20°C
Vap. Press. 0.01 mm @20°C
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

n-**HEXYL "CELLOSOLVE"**
Description: Liquid.
Formula: $C_6H_{13}OCH_2CH_2OH$
Constants:
Mol. Wt. 146.22
B. P. 208.3°C
Freezing P. −45.1°C
Flash P. 195°F (O.C.)
Density 0.8894 @20°/20°C
Vap. Press. 0.1 mm @20°C
Vap. D. 5.04
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

HEXYL DIETHYL HEPTYLATE
Synonym: Flexol Plasticizer CC-55.
Description: Liquid.
Formula:
$C_6H_{10}[COOCH_2CH(C_2H_5)C_4H_9]_2$
Constants:
Mol. Wt. 376.59
M. P. −53°C
B. P. 216°C @5 mm
Flash P. 425°F (O.C.)
Density 0.9586 @20°/20°C
Vap. D. 13.7
Toxicity: Details unknown. See also Esters.
Fire Hazard: Slight, when exposed

to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

HEXYLENE GLYCOL
Synonym: 2-Methyl pentanediol-2,4.
Description: Mild odor, colorless liquid, water soluble.
Formula:
$CH_3COH(CH_3)CH_2CHOHCH_3$
Constants:
Mol. Wt. 118.17
B. P. 197.1°C
Freezing P. −50°C
Flash P. 215°F (O.C.)
Density 0.9234 @20°/20°C
Vap. Press. 0.05 mm @20°C
Vap. D. 4
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon tetrachloride, carbon dioxide or dry chemicals (Section 6).
Storage and Handling: Section 7

HEXYL ETHER
Synonym: Dihexyl ether.
Description: Liquid.
Formula: $C_6H_{13}OC_6H_{13}$
Constants:
Mol. Wt. 186.33
M. P. −43.0°C
B. P. 440°F
Flash P. 170°F(O.C.)
Density 0.794
Toxicity: Details unknown. See also Ethers.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Details unknown. See also Ethers.
Storage and Handling: Section 7

N,n-**HEXYL**-n-**HEPTYL AMINE**
Formula: $(C_6H_{13})_2(C_7H_{15})N$
Constant:
Mol. Wt. 283.5
Toxicity: Details unknown. See also Amines.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Storage and Handling: Section 7

HEXYL TITANATE. See 2-Ethyl Butyl Titanate.

HEXYL TRICHLOROSILANE
Formula: $C_7H_{15}Cl_3Si$
Constant:
Mol. Wt. 234.6
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

HISTAMINE
Synonyms: 4-Imidazole ethylamine; ergamine.
Description: Deliquescent needles.
Formula: $C_5H_9N_3$
Constants:
Mol. Wt. 111.2
M. P. 84°C
B. P. 210°C @18 mm
Toxic Hazard Rating:
Acute Local: Allergen 2
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Allergen 1
Chronic Systemic: U
Toxicology: Ingestion or inhalation of this material produces the following effects: flushing followed by pallor, dizziness, fainting, fall in blood pressure, headache, rapid, weak pulse. Allergic effects on skin (hives) may occur (Section 9).
Treatment and Antidotes: If swallowed, wash out stomach.

Administer stimulants (epinephrine or ephedrine). Call a physician.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

HISTAMINE SALTS. See Histamine.

HOLMIUM
Description: Yellow-colored salts.
Formula: Ho
Constant:
At. Wt. 164.94
Toxicity: Unknown
Radiation Hazard: Section 5. Artificial isotope Ho^{166}, half-life 27 hours; emits beta particles of 1.8 mev and gamma rays of 0.8 mev. The permissible levels are: In body: 17 microcuries; In air: 3×10^{-6} microcuries per milliliter; In water: 23 microcuries per milliliter.

HOMATROPINE AND COMPOUNDS
Synonyms: Mandelytropeine, homoatropine.
Description: Deliquescent prisms from ether; glistening prisms from alcohol.
Formula: $C_{16}H_{21}NO_3$
Constants:
Mol. Wt. 275.34
M. P. 95.5° - 98.5°C
Toxic Hazard Rating:
Acute Local: O
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: O
Chronic Systemic: U
Toxicology: A poisonous alkaloid. Resembles atropine in its action. See also Atropine.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

HORN DUST
Toxic Hazard Rating:
Acute Local: Allergen 1; Inhalation 1
Acute Systemic: U
Chronic Local: Allergen 1; Inhalation 1
Chronic Systemic: U
MAC: ACGIH (accepted); 50 million particles per cubic foot of air.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

HORNSTONE. See Magnesium Fluosilicate and Zinc Fluosilicate.

HORSEHAIR. See Hair.

HYDRASTINE
Description: Colorless, rhombic prisms; white pulverulent alkaloid.
Formula: $C_{21}H_{21}NO_6$
Constants:
Mol. Wt. 383.39
M. P. 132°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

HYDRASTININE
Description: White-yellowish needles.
Formula: $C_{11}H_{13}NO_3$
Constants:
Mol. Wt. 207.2
M. P. 116 - 117°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

HYDRAZINE (and Compounds)

Synonyms: Hydrazine base; diamine; hydrazine anhydrous.
Description: Colorless, fuming liquid; white crystals.
Formula: NH_2NH_2
Constants:
- Mol. Wt. 32.05
- M. P. 1.4°C
- B. P. 113.5°C
- Flash P. 126°F (O. C.)
- Density 1.011 @15°C (liq.)
- Autoign. Temp. 518°F
- Vap. D. 1.1

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: Ingestion 3; Inhalation 3
- Chronic Local: U
- Chronic Systemic: Ingestion 3; Inhalation 3

MAC: ACGIH (tentative); 1 part per million in air.
Toxicology: Hydrazine and some of its derivatives may cause damage to the liver and destruction of red blood cells. See Phenyl Hydrazine.
Fire Hazard: Moderate, when exposed to heat, flame, or oxidizing agents; a powerful reducing agent.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Severe, when exposed to heat or flame or by chemical reaction with oxidizing agents. It is a powerful explosive, much used in rocket fuels. It is very sensitive and must not be used without full and complete instructions from the manufacturer as to handling, storage and disposal.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of nitrogen compounds; may explode by heat or chemical reaction.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
- Coast Guard Classification: Corrosive liquid; white label.

HYDRAZINE, ANHYDROUS. See also Hydrazine.

Shipping Regulations: Section 11.
- I. C. C. Classification: Corrosive liquid; white label.
- Coast Guard Classification: Corrosive liquid; white label.

HYDRAZOIC ACID

Synonym: Azoimide.
Description: Colorless liquid.
Formula: NH_3
Constants:
- Mol. Wt. 43.03
- M. P. -80°C
- B. P. 37°C

Toxic Hazard Rating:
- Acute Local: Irritant 2; Ingestion 2; Inhalation 2
- Acute Systemic: Ingestion 3; Inhalation 3
- Chronic Local: U
- Chronic Systemic: U

Toxicology: Low concentrations produce eye irritation and headache. Higher concentrations may produce excitation and other disturbances of the nervous system and if exposure is continued there may be convulsions and death. See also Azides.
Explosion Hazard: Moderate, when shocked or exposed to heat.
Disaster Control: Dangerous; shock or heat will explode it.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

HYDRIDES

Toxicity: Variable. The hydrides of phosphorus, arsenic, sulfur, selenium, tellurium and boron which are highly toxic, produce local irritation and destroy red blood cells. They are particularly dangerous because of their volatility and ease of entry into the body. The hydrides of the alkali metals, alkaline earths, aluminum, zirconium and titanium react with moisture to evolve hydrogen and leave behind the hydroxide of the metallic element. This hydroxide is usually caustic. See also Sodium Hydroxide.
Fire Hazard: The volatile hydrides

are flammable, some spontaneously so in air. All hydrides react violently on contact with powerful oxidizing agents. When heated or on contact with moisture or acids an exothermic reaction evolving hydrogen occurs. Often enough heat is evolved to cause ignition. Hydrides require special handling instructions which should be obtained from the manufacturers (Section 6).

Explosion Hazard: The volatile hydrides (such as hydrides of boron, arsenic, phosphorus, selenium, telliurim) form explosive mixtures with air. The nonvolatile hydrides (such as sodium, lithium, calcium) readily liberate hydrogen when heated or on contact with moisture or acids. Furthermore, hydrides form dust clouds which can explode due to contact with flames, sparks, heat or oxidizers.

Disaster Control: Highly dangerous; when heated, they can ignite at once or liberate hydrogen: they react with moisture or acids to evolve heat and hydrogen; on contact with powerful oxidizers violent reactions can occur.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

HYDRIODIC ACID

Description: Colorless gas or pale yellow liquid.

Formula: HI

Constants:
- Mol. Wt. 127.93
- M. P. -50.8°C
- B. P. -35.38° @4 atm.
- Density 5.66 g/liter @0°C

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: Ingestion 2; Inhalation 2
- Chronic Local: U
- Chronic Systemic: Ingestion 2; Inhalation 2

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of iodides; will react with water or steam to produce toxic and corrosive fumes.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations. Section 11.
- I.C.C. Classification: Corrosive liquid; white label.
- Coast Guard Classification: Corrosive liquid; white label.

HYDROABIETYL ALCOHOL

Description: Colorless, tacky, viscous liquid.

Constants:
- Flash P. 380°F (O.C.)
- Density 1.007-1.008 @20°/20°C
- Softening P. 33°C

Toxicity: Details unknown. See also Alcohols.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

HYDROBERBERINE

Description: White, crystalline alkaloid.

Formula: $C_{20}H_{21}NO_4$

Constants:
- Mol. Wt. 339.4
- M. P. 167°C

Toxic Hazard Rating:
- Acute Local: U
- Acute Systemic: Ingestion 3; Inhalation 3
- Chronic Local: U
- Chronic Systemic: U

Disaster Control: Dangerous; when heated to decomposition, it can emit highly toxic fumes of nitrogen oxides.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

HYDROBROMIC ACID

Synonym: Hydrogen bromide.

Description: Colorless gas or pale yellow liquid.

Formula: HBr
Constants:
Mol. Wt. 80.92
M. P. −87°C
B. P. −66.5°C
Density 3.50 g/liter @0°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: Irritant 2
Chronic Systemic: Ingestion 2; Inhalation 2
MAC: ACGIH (tentative); 5 parts per million in air.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromides; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.
Coast Guard Classification: Noninflammable gas; green gas label.

HYDROCARBON GAS. See Gases, Hydrocarbon.

HYDROCARBON GAS, LIQUEFIED. See specific gas.
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable gas; red gas label.
Coast Guard Classification: Inflammable gas; red gas label.

HYDROCARBON GAS, NONLIQUEFIED. See specific material.
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable gas; red gas label.
Coast Guard Classification: Inflammable gas; red gas label.

HYDROCHLORIC ACID
Synonyms: Muriatic acid; chlorohydric acid; hydrogen chloride.
Description: Colorless gas or colorless, fuming liquid; strongly corrosive.
Formula: HCl
Constants:
Mol. Wt. 36.47
M. P. −114.3°C
B. P. −84.8°C
Density 1.639 g/liter @0°C; 1.194 @−36°C (liquid)
Vap. Press. 4.0 atm @17.8°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: Irritant 2
Chronic Systemic: U
MAC: ACGIH (accepted); 5 parts per million in air; 8 milligrams per cubic meter of air.
Toxicology: Hydrochloric acid is an irritant to the mucous membranes of the eyes and respiratory tract, and a concentration of 35 ppm causes irritation of the throat after short exposure. Concentrations of 50 to 100 ppm are tolerable for 1 hour. More severe exposures result in pulmonary edema, and often laryngeal spasm. Concentrations of 1,000 to 2,000 ppm are dangerous, even for brief exposures. Mists of hydrochloric acid are considered less harmful than the anhydrous hydrogen chloride, since the droplets have no dehydrating action. In general, hydrochloric acid causes little trouble in industry, other than from accidental splashes and burns.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
First Aid: Section 1
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.
Coast Guard (anhydrous) Classification: Noninflammable gas; green gas label.
MCA warning label.

HYDROCHLORIC ACID, MIXTURES.

See Hydrochloric Acid.
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

HYDROCOTARNINE

Description: Monoclinic prisms.
Formula: $C_{12}H_{15}NO_3 \cdot \frac{1}{2}H_2O$
Constants:
Mol. Wt. 230.3
M. P. 56 °C
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it can emit highly toxic fumes of nitrogen compounds.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

HYDROCYANIC ACID

Synonyms: Hydrogen cyanide; prussic acid.
Description: Colorless liquid; faint odor of bitter almonds.
Formula: HCN
Constants:
Mol. Wt. 27.03
M. P. −13.2 °C
B. P. 25.7 °C
Flash P. 0 °F (C. C.)
Density 0.6876 @20°/4 °C
Autoign. Temp. 1000 °F
Vap. Press. 400 mm @9.8 °C
Vap. D. 0.932
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (accepted); 10 parts per million in air; 11 milligrams per cubic meter of air.
Toxicology: Hydrocyanic acid and the cyanides are true protoplasmic poisons, combining in the tissues with the enzymes associated with cellular oxidation. They thereby render the oxygen unavailable to the tissues, and cause death through asphyxia. The suspension of tissue oxidation lasts only while the cyanide is present; upon its removal, normal function is restored provided death has not already occurred. Hydrocyanic acid does not combine easily with hemoglobin, but it does combine readily with methemoglobin to form cyanmethemoglobin. This fact is utilized in the treatment of cyanide poisoning, when an attempt is made to induce methemoglobin formation. The presence of cherry-red venous blood in cases of cyanide poisoning is due to the inability of the tissues to remove the oxygen from the blood. Exposure to concentrations of 100 to 200 ppm for periods of 30 to 60 minutes can cause death.

In cases of acute cyanide poisoning, death is extremely rapid; though sometimes breathing may continue for a few minutes. In less acute cases, there is headache, dizziness, unsteadiness of gait, a feeling of suffocation, and nausea. Where the patient recovers, there is rarely any disability.

Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, nonalkaline dry chemical or foam (Section 6).
Explosion Hazard: Severe, when exposed to heat or flame or by chemical reaction with oxidizers. Under certain conditions, particularly contact with alkaline materials, hydrogen cyanide can polymerize or decompose explosively. The liquid is commonly stabilized by addition of acids.
Explosive Range: 6 - 40%
Disaster Control: Highly dangerous; the gas forms explosive mixtures with air; will react with water, steam, acid or acid fumes to produce highly toxic fumes of cyanides.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison A;

poison gas label.
Coast Guard Classification: Poison A; poison gas label.
MCA warning label.

HYDROCYANIC ACID SOLUTION.

See Hydrocyanic Acid.
Shipping Regulations: Section 11
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison gas label.

HYDROCYANIC ACID, UNSTABILIZED.

See Hydrocyanic Acid.
Shipping Regulations: Section 11.
I. C. C. Classification: Not accepted.
Coast Guard Classification: Not permitted.

HYDROFERROCYANIC ACID

Description: White crystalline material.
Formula: $H_4Fe(CN)_6$
Constant:
Mol. Wt. 216
Toxicity: See Ferrocyanides.
Disaster Control: Dangerous; when heated to decomposition or in the presence of acid or acid fumes, it emits highly toxic fumes of cyanides.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

HYDROFLUORIC ACID

Synonyms: Hydrogen fluoride; fluorhydric acid.
Description: Clear, colorless, fuming corrosive liquid or gas.
Formula: HF
Constants: Mol. Wt. 20.01
M. P. -92.3°C
B. P. 19.4°C
Density 0.921 g/liter (gas): 0.987 (liquid)
Vap. Press. 400 mm @2.5°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Irritant 2
Chronic Systemic: Ingestion 2; Inhalation 2
MAC: ACGIH (accepted); 3 parts per million in air; 2.5 milligrams per cubic meter of air.
Toxicology: It is extremely irritating and corrosive to the skin and mucous membranes. Inhalation of the vapor may cause ulcers of the upper respiratory tract. Concentrations ot 50 to 250 ppm are dangerous, even for brief exposures. Hydrofluoric acid produces severe skin burns which are slow in healing. The subcutaneous tissues may be affected, becoming blanched and bloodless. Gangrene of the affected areas may follow. See also Fluorides.
Disaster Control: Dangerous; shock can shatter the container with explosive force; when heated, it emits highly corrosive fumes of fluorides; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.
MCA warning label.

HYDROFLUORIC ACID, ANHYDROUS.

See Hydrofluoric Acid.
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.
MCA warning label.

HYDROFLUOSILICIC ACID

Synonyms: Fluosilicic acid; silicofluoric acid.
Description: Transparent, colorless, fuming liquid.
Formula: H_2SiF_6
Constants: Mol. Wt. 144.08
B. P. Decomposes
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U

Chronic Systemic: Ingestion 3; Inhalation 3
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic and corrosive fumes of fluorides; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

HYDROFURAMIDE
Description: Light brown crystals.
Formula: $(C_4H_3OCH_3)_3N_2$
Constants:
Mol. Wt. 268.26
M. P. 117°C
B. P. 250°C Decomposes
Toxicity: Details unknown; a component of fungicides.
Disaster Control: Slight; when heated to decomposition, it emits toxic fumes of nitrogen compounds.
Storage and Handling: Section 7

HYDROGEN
Description: Colorless gas.
Formula: H_2
Constants:
Mol. Wt. 2.0162
M. P. −259.18°C
B. P. −252.8°C
Density 0.0899 g/liter
Autoign. Temp. 1085°F
Vap. D. 0.069
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Inhalation 1
Chronic Local: 0
Chronic Systemic: 0
Radiation Hazard (Section 5): Natural or artificial isotope H^3 (Tritium), half-life: 12.5 years; emits beta particles of 0.018 mev. The permissible levels are: in body: 10^4 microcuries; in air: 2×10^{-5} microcurie per milliliter; in water: 0.2 microcurie per milliliter.

Tritium occurs naturally in very small quantities as a result of natural neutron bombardment of deuterium. Hazard Rating, Class II (National Bureau of Standards Handbook No. 42).
Fire Hazard: Highly dangerous; when exposed to heat or flame.
To Fight Fire: Carbon dioxide or dry chemical (Section 6).
Explosion Hazard: Severe, when exposed to heat or flame.
Explosive Range: 4.1 - 74.2%
Disaster Control: Dangerous; shock can shatter the compressed gas container with explosive force; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable gas; red gas label.
I. C. C. Classification: (Liquefied) not accepted.
Coast Guard Classification: Inflammable gas; red gas label.
Coast Guard Classification: (Liquefied) not permitted.

HYDROGEN ANTIMONIDE
Synonym: Stibine.
Description: Colorless gas.
Formula: H_3Sb
Constants:
Mol. Wt. 124.8
M. P. −88°C
B. P. −17°C
Density 2.26 @−25°C (liq.); 5.30 g/liter @0°C
Toxicity: Highly toxic. See Antimony Compounds and Hydrides.
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of antimony; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

HYDROGEN ARSENIDE (GAS).
See Arsine.

HYDROGEN ARSENIDE (SOLID)
Description: Brown powder.
Formula: H_2As_2
Constants:
  Mol. Wt. 151.84
  M. P. Decomposes @200°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: Ingestion 3; Inhalation 3
Fire Hazard: Moderate, by chemical reaction with oxidizers.
Explosion Hazard: Details unknown. See also Hydrides.
Disaster Control: Dangerous; when heated to decomposition, it evolves highly toxic fumes of arsenic.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

HYDROGEN BISMUTHIDE
Synonym: Bismuthine.
Description: Liquid.
Formula: H_3Bi
Constants:
  Mol. Wt. 212.02
  B. P. 22°C
Toxicity: See Bismuth Compounds and Hydrides.
Fire Hazard: See Hydrides.
Explosion Hazard: See Hydrides.
Disaster Control: See Bismuth Compounds and Hydrides.
Storage and Handling: Section 7

HYDROGEN BROMIDE. See Hydrobromic Acid.
Shipping Regulations: Section 11.
  I. C. C. Classification: Nonflammable gas; green label.
  Coast Guard Classification: Noninflammable gas; green gas label.

HYDROGEN BROMIDE (CONSTANT BOILING MIXTURE)
Description: Colorless liquid.
Formula: HBr (47%) + H_2O
Constants:
  M. P. -11°C
  B. P. 126°C
  Density 1.49
Toxicity: See Hydrobromic Acid.
Disaster Control: See Hydrobromic Acid.
Storage and Handling: Section 7

HYDROGEN BROMIDE, HYDRATED
Description: Colorless liquid.
Formula: $HBr \cdot H_2O$
Contants:
  Mol. Wt. 98.94
  B. P. -3.3° to -15°C
  Density 1.78
Toxicity: See Hydrobromic Acid.
Disaster Control: See Hydrobromic Acid.
Storage and Handling: Section 7

HYDROGEN CHLORIDE. See Hydrochloric Acid.
Shipping Regulations: Section 11.
  I. C. C. Classification: Nonflammable gas; green label.
  Coast Guard Classification: Noninflammable gas; green gas label.
  MCA warning label.

HYDROGEN CYANIDE. See Hydrocyanic Acid.

HYDROGEN DISULFIDE
Description: Yellow oil.
Formula: H_2S_2
Constants:
  Mol. Wt. 66.15
  M. P. -89.7°C
  B. P. 74.5°C
  Density 1.376
  Vap. Press. 100 mm @22.0°C
Toxicity: Details unknown; probably highly toxic. See also Hydrogen Sulfide.
Fire Hazard: Unknown
Explosion Hazard: Unknown
Disaster Control: See Sulfides.

HYDROGEN FLUORIDE. See Hydrofluoric Acid.

HYDROGEN IODIDE. See Hydriodic Acid.

HYDROGEN PENTASULFIDE
Description: Clear yellow oil.
Formula: H_2S_5

Constants:
Mol. Wt. 162.35
M. P. Decomposes
Density 1.67 @16°C
Toxicity: Details unknown; probably highly toxic. See also Hydrogen Sulfide.
Fire Hazard: Unknown, but probably high.
Explosion Hazard: Unknown, but may be dangerous;
Disaster Control: Keep containers closed and avoid heat and open flame.

HYDROGEN PEROXIDE

Synonym: Hydrogen Dioxide.
Description: Colorless, heavy liquid or at low temperatures a crystalline solid.
Formula: H_2O_2
Constants:
Mol. Wt. 34.016
B. P. 107°C for 35 wt%
Freezing P. -11°C for 90 wt%
Density 1.71 @-20°C; 1.46 @0°C
Vap. Press. 1 mm @15.3°C
Toxic Hazard Rating: (For concentrated solutions)
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (tentative); 1 part per million of air for 90 wt% solution.
Toxicology: Pure H_2O_2, its solutions, vapors and mists are irritating to body tissue. This irritation can vary from mild to severe depending upon the concentration of H_2O_2. For instance solutions of H_2O_2 of 35 wt% and over can easily cause blistering of the skin. Irritation caused by H_2O_2 which does not subside upon flushing of the affected part with water should be treated by a physician. The eyes are particularly sensitive to irritation by this material.
Fire Hazard: Dangerous by chemical reaction with flammable materials. H_2O_2 is a powerful oxidizer, particularly in the concentrated state. It is important to keep containers of this material covered because (1) uncovered containers are much more prone to react with flammable vapors, gases, etc.; (2) because if uncovered, the water from an H_2O_2 solution can evaporate, concentrating the material and thus increasing the fire hazard of the remainder.

For instance, solutions of H_2O_2 of concentrations in excess of 65 wt% heat up spontaneously when decomposing to $H_2O + \frac{1}{2}O_2$. Thus 90 wt% solutions, when caused to decompose rapidly due to the introduction of a catalytic decomposition agent, can get quite hot and perhaps start fires.
Explosion Hazard: Severe, when highly concentrated or pure H_2O_2 is exposed to heat, mechanical impact, detonation of a blasting cap, or caused to decompose catalytically by metals and their salts, dusts and alkalies.

Although many mixtures of H_2O_2 and organic materials do not explode upon contact, the resultant combination is detonatable either upon catching fire or by impact.

The detonation velocity of aqueous solutions of H_2O_2 has been found to be about 6500 meters/second for solutions of between 96 wt% and 100 wt% H_2O_2.

Another source of H_2O_2 explosions is from sealing the material in strong containers. Under such conditions even gradual decomposition of H_2O_2 to $H_2O + \frac{1}{2}O_2$ can cause large pressures to build up in the containers which may then burst explosively. See also Schumb, Satterfield, and Wentworth "Hydrogen Peroxide," pp. 174, 453.
Disaster Hazard: Highly dangerous because when heated, or shocked or contaminated, the concentrated material can explode or start fires.
Personnel Protection: Section 3
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7 (See also Schumb, Satterfield and Wentworth, "Hydrogen Peroxide," pp. 172 - 176.
Shipping Regulations: Section 11.
Coast Guard Classification:
(Corrosive Liquid) Solution

in water containing over 8% Hydrogen Peroxide by weight; white label.
MCA warning label (for solutions above 7.4%).

HYDROGEN PHOSPHIDE
Description: Colorless liquid.
Formula: H_4P_2
Constants: Mol. Wt. 65.99
M. P. < −10°C
B. P. 57.5°C @735 mm
Density 1.012
See Phosphine and Phosphides.

HYDROGEN PHOSPHIDE. See Phosphine.

HYDROGEN PHOSPHIDE (POLYMER)
Description: Yellow solid.
Formula: $(H_2P_4)_3$
Constants:
Mol. Wt. 377.81
M. P. Ignites @160°C
B. P. Decomposes
Density 1.83 @19°C
See Phosphine and Phosphides.

HYDROGEN SELENIDE
Description: Colorless gas.
Formula: H_2Se
Constants:
Mol. Wt. 80.98
M. P. −64°C
B. P. −41.4°C
Density 3.614 g/liter (gas): 2.12 @−42°C (liquid)
Vap. Press. 10 atm. @23.4°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Allergen 1; Inhalation 3
Acute Systemic: Inhalation 3
Chronic Local: Allergen 1
Chronic Systemic: Inhalation 3
MAC: ACGIH (accepted); 0.05 parts per million in air; 0.17 milligrams per cubic meter of air.
Toxicology: This material is a hazardous compound of selenium which can cause damage to the lungs and liver as well as conjunctivitis. It has been found that repeated 8-hour exposures to concentrations of 0.3 ppm prove fatal to guinea pigs by causing a pneumonitis, as well as injury to the liver and spleen. Concentrations of 0.3 ppm are readily detected by odor, but there is no noticeable irritant effect at that level. Concentrations of 1.5 ppm or higher are strongly irritating to the eyes and nasal passages.

As in the case of hydrogen sulfide, the odor of hydrogen selenide in concentrations below 1 ppm disappears rapidly because of olfactory fatigue. Although the odor and irritating effects are both useful to an experienced investigator for estimating the concentrations, they do not offer a dependable warning to workmen who may be exposed to gradually increasing amounts and therefore become used to it. Due to its extreme toxicity and irritant effects, it seldom is allowed to reach a concentration in which it is flammable in air.

Very few data are available on possible chronic effects of this material, but it is logical to assume that when the concentration of this gas is low enough to avoid the irritant effects, only the systemic effects will be noticeable.
Fire Hazard: Dangerous; will react vigorously with powerful oxidizing agents.
Explosion Hazard: Dangerous; forms explosive mixtures with air. See also Hydrides.
Disaster Control: Highly dangerous; keep away from heat and open flame.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

HYDROGEN SULFIDE
Synonym: Sulfuretted hydrogen.
Description: Colorless; flammable gas; offensive odor.
Formula: H_2S
Constants:
Mol. Wt. 34.08
M. P. −85.5°C
B. P. −60.4°C
Autoign. Temp. 500°F
Density 1.539 g/liter @0°C
Vap. Press. 20 atm @25.5°C
Vap. D. 1.189

Toxic Hazard Rating:
  Acute Local: Irritant 3; Inhalation 3
  Acute Systemic: Inhalation 3
  Chronic Local: Irritant 3
  Chronic Systemic: Inhalation 3
MAC: ACGIH (accepted); 20 parts per million in air; 28 milligrams per cubic meter of air.
Toxicology: Hydrogen sulfide is both an irritant and an asphyxiant. Low concentrations of from 20 to 150 ppm cause irritation of the eyes; slightly higher concentrations may cause irritation of the upper respiratory tract, and if exposure is prolonged, pulmonary edema may result. The irritant action has been explained on the basis that H_2S combines with the alkali present in moist surface tissues to form sodium sulfide, a caustic.

With higher concentrations the action of the gas on the nervous system becomes more prominent, and a 30-minute exposure to 500 ppm results in headache, dizziness, excitement, staggering gait, diarrhea and dysuria, followed sometimes by bronchitis or bronchopneumonia. The action on the nervous system is, with small amounts, one of depression; in larger amounts, it stimulates, and with very high amounts the respiratory center is paralyzed. Exposures of 800 to 1000 ppm may be fatal in 30 minutes, and high concentrations are instantly fatal. Fatal hydrogen sulfide poisoning may occur even more rapidly than that following exposure to a similar concentration of hydrogen cyanide. H_2S does not combine with the hemoglobin of the blood; its asphyxiant action is due to paralysis of the respiratory center.

With repeated exposures to low concentrations, conjunctivitis, photophobia, corneal bullae, tearing, pain and blurred vision are the commonest findings. High concentrations may cause rhinitis, bronchitis and occasionally pulmonary edema. Exposure to very high concentrations results in immediate death. Chronic poisoning results in headache, inflammation of the conjunctivae and eyelids, digestive disturbances, loss of weight and general debility.

Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or water spray (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 4.3 - 46%
Disaster Control: Highly dangerous; shock can shatter the compressed gas container with explosive force; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable gas; red gas label.
  Coast Guard Classification: Inflammable gas; red gas label.
  MCA warning label.

HYDROGEN TELLURIDE

Description: Colorless gas or yellow needles.
Formula: H_2Te
Constants:
  Mol. Wt. 129.63
  M. P. −49.0 °C
  B. P. −2.0 °C
  Density 5.81 g/liter
Toxicity: Highly toxic. See Tellurium Compounds and Hydrides.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: Details unknown. See also Hydrides.
Disaster Control: See Tellurium Compounds and Hydrides.

HYDROGEN TRISULFIDE

Description: Bright yellow liquid.
Formula: H_2S_3
Constants:
  Mol. Wt. 98.21
  M. P. −52 °C
  B. P. Decomposes @90 °C
  Density 1.496 @15 °C

Toxicity: Highly toxic. See also Hydrogen Sulfide.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

HYDROHYDRASTININE

Description: White crystalline alkaloid.
Formula: $C_{11}H_{13}NO_2$
Constants: Mol. Wt. 191.22
M. P. 66°C
B. P. 303°C @752 mm
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

p-HYDROQUINONE

Synonyms: 1,4-Benzenediol; quinol; hydroquinol.
Description: Colorless, hexagonal prisms.
Formula: $C_6H_4(OH)_2$
Constants:
Mol. Wt. 110.1
M. P. 170.5°C
B. P. 286.2°C
Flash P. 329°F (C. C.)
Density 1.358 @20°/4°C
Autoign. Temp. 960°F
Vap. Press. 1 mm @132.4°C
Vap. D. 3.81
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 1
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: Allergen 2
Chronic Systemic: Ingestion 2; Inhalation 2
MAC: ACGIH (tentative); 12 milligrams per cubic meter of air.

Toxicology: Absorption of this material by tissues can cause symptoms of illness which resemble those induced by its ortho or meta isomer. For instance, the ingestion of 1 gram by an adult or a smaller quantity by a child may induce tinnitis, nausea, dizziness, a sensation of suffocation, an increased rate of respiration, vomiting, pallor, muscular twitchings, headache, dyspnea, cyanosis, delerium, and collapse. The literature contains reports of fatal cases which have been caused by the ingestion of 5 to 12 grams. Cases of dermatitis have resulted from skin contact with this material, and have also followed the application of an antiseptic oil which apparently contained traces of hydroquinone added as an antioxidant. The reports also contain cases of keratitis and discoloration of the conjunctiva among personnel exposed to this material in concentrations ranging from 10 to 30 mg of the vapor or dust per cubic meter of air. It is considered to be more toxic than phenol. The inhalation of vapors of this material, particularly when liberated at high temperatures, must be avoided. From toxicity experiments on mice, it has been found that the LD50* via the intraperitoneal route is from 160 to 170 mg/kg of body weight. For the rat via the same route, 170 to 175 mg/kg, and for the rat via the oral route, 370 to 390 mg/kg. Finally, for the rabbit via the intraperitoneal route, the LD50* has been found to be 125 to 150 mg/kg.

Treatment and Antidotes: When personnel who are working with this material exhibit some of the symptoms listed above, they should immediately be removed to fresh air. If the symptoms do not subside quickly, consult a physician. In cases of dermatitis due to this material, removal from exposure will quickly clear up the symptoms. If this material accidentally comes into contact with the skin, it should be removed at once and the affected area washed with plenty of soap and warm water.

Fire Hazard: Slight, when exposed to heat or flame; can react

with oxidizing materials.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Slight, when exposed to heat.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

HYDROQUINONE DIMETHYL ETHER
Synonym: 1, 4-Dimethoxybenzene.
Description: Colorless leaflets; odor of sweet clover.
Formula: $C_6H_4(OCH_3)_2$
Constants:
  Mol. Wt. 138.16
  M. P. 56°C
  B. P. 212.6°C
  Density 1.053 @55°/55°C
Toxic Hazard Rating:
  Acute Local: Irritant 1; Allergen 1; Ingestion 1; Inhalation 1
  Acute Systemic: Ingestion 1; Inhalation 1
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Details unknown. See also Ethers.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

HYDROQUINONE MONOBENZYL ETHER
Formula: $HOC_6H_4OC_6H_5$
Constant:
  Mol. Wt. 186.2
Toxicity: Details unknown. Can cause permanent depigmentation of skin.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Explosion Hazard: Details unknown. See also Ethers.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

HYDROQUINONE MONOMETHYL ETHER
Synonym: 4-Methoxy phenol; hydroxy anisole.
Description: White, waxy solid.
Formula: $CH_3OC_6H_4OH$
Constants:
  Mol. Wt. 124.13
  M. P. 52.5°C
  B. P. 246°C
  Density 1.55 @20°/20°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Details unknown. See also Ethers.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

HYDROUS MAGNESIUM SILICATE.
See Talc.

HYDROXYACETIC ACID
Synonym: Glycolic
Description: Light straw-colored liquid or crystals.
Formula: $HOCH_2COOH$
Constants:
  Mol. Wt. 76.1
  M. P. $a = 63°C$; $\beta = 79°C$
  B. P. Decomposes
  Vap. D. 2.62
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1; Inhalation 1
  Acute Systemic: U
  Chronic Local: Irritant 1
  Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

o- HYDROXYACETOPHENONE
Description: Greenish-yellow liquid; highly refractive; minty odor.
Formula: $C_6H_4(OH)COCH_3$
Constants: Mol. Wt. 136.14
  M. P. 95°C
  Vap. D. 4.69

Toxicity: Unknown
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

2-HYDROXYADIPALDEHYDE (25% AQUEOUS SOLUTION)
Description: Liquid.
Formula: $OHC(CH_2)_3CH(OH)CHO$
Constants:
Mol. Wt. 130.1
Freezing P. −3.5°C
Density 1.066 @20°/20°C
Vap. Press. 17 mm @20°C
Toxicity: Details unknown. See also Aldehydes.
Fire Hazard: Slight; when heated; it emits acrid fumes (Section 6).
Storage and Handling: Section 7

β-HYDROXY ANTHRAQUINONE
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

4-HYDROXY-3,5-DI-tert-BUTYLTOLUENE. See Di-tert-Butyl-p-Cresol.

p-HYDROXY DIPHENYLAMINE
Synonym: Anilinophenol.
Description: Gray solid leaflets.
Formula: $C_6H_5NHC_6H_4OH$
Constants: Mol. Wt. 185.2
M. P. 70°C
B. P. 330°C
Toxicity: Details unknown. See also Aniline and Phenol.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of aniline.
Storage and Handling: Section 7

HYDROXYETHYL ACETAMIDE
Synonym: n-Acetyl ethanolamine.
Description: Brown, viscous liquid.
Formula: $CH_3CONHC_2H_4OH$
Constants: Mol. Wt. 103.12
B. P. 151°C
Flash P. 350°F
Freezing P. 15.8°C
Density 1.122 @20°/20°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

HYDROXYETHYLENE DIAMINE
Description: Clear liquid.
Formula: $NH_2CHOHCH_2NH_2$
Constant:
Mol. Wt. 76.1
Toxicity: Details unknown. See also Amines.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

1-HYDROXYETHYL-2-HEPTADECENYLIMIDAZOLINE
Description: Yellow liquid.
Formula:
$C_{17}H_{33}C[N(C_2H_4OH)CH_2CH_2N]$
Constants:
Mol. Wt. 350
B. P. 250 - 280°C @2 mm
Density 0.95 @20°C
Toxicity: Details unknown. See also Amines.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

1-HYDROXYETHYL-2-HEPTADECYLGLYOXALIDINE
Toxicity: Details unknown; plant fungicide.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

β-HYDROXYETHYL HYDRAZINE
Description: Colorless, slightly viscous liquid.
Formula: $HOCH_2CH_2NHNH_2$
Constants:
Mol. Wt. 76.12
M. P. −70°C
B. P. 145 - 153°C @25mm
Flash P. 224°F
Vap. D. 2.63
Toxicity: Highly toxic. See Hydrazine.
Fire Hazard: Moderate, when exposed

to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

n-HYDROXYETHYL MORPHOLINE

Description: Liquid.
Formula: $\underline{C_2H_4OC_2H_4N}C_2H_4OH$
Constants:
Mol. Wt. 131.7
M. P. 1.6°C
B. P. 226.3°C
Flash P. 215°F (O.C.)
Density 1.074 @20°/20°C
Vap. Press. 0.1 mm @20°C
Vap. D. 4.54
Toxicity: Unknown
Fire Hazard: Moderate; when exposed to heat or flame, can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

n-HYDROXYETHYL PROPYLENE DIAMINE

Description: Liquid.
Formula:
$CH_3CH(NHC_2H_4OH)CH_2NH_2$
Constants:
Mol. Wt. 118.18
M. P. −65°C
B. P. 240.4°C
Flash P. 260°F (O.C.)
Density 0.9938
Vap. D. 4.07
Toxicity: Details unknown. See also Amines.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2-HYDROXYETHYL TRIMETHYL AMMONIUM BICARBONATE

Description: A colorless liquid.
Formula: $(CH_3)_3NCH_2CH_2OHHCO_3$
Constants:
Mol. Wt. 165.19
B. P. Loses CO_2
Freezing P. −21.3°C
Density 1.0965 @25°/4°C
Toxicity: Details unknown. See also Sodium Carbonate.

HYDROXYLAMINE

Synonym: Oxammonium.
Description: Colorless liquid or white needles.
Formula: NH_2OH
Constants:
Mol. Wt. 33.02
M. P. 34.0°C
B. P. 110.0°C
Flash P. Explodes @265°F
Density 1.227
Vap. Press. 10 mm @47.2°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
Explosion Hazard: Dangerous; when exposed to heat or open flame.
Disaster Control: Dangerous, upon exposure to heat or flame.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

HYDROXYLAMINE ACID SULFATE

Synonym: Hydroxylammonium sulfate.
Description: Crystalline white to brown solid.
Formula: $(NH_2OH)_2 \cdot H_2SO_4$
Constants: Mol. Wt. 164.14
M. P. 177°C
B. P. Decomposes
Toxicity: Toxic. See also Hydroxylamine and Sulfuric Acid.
Disaster Control: Dangerous; on decomposition, it emits highly toxic fumes of oxides of sulfur.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

HYDROXYLAMINE FLUOGERMANATE

Description: Monoclinic prisms.
Formula: $2NH_2OH \cdot H_2GeF_6 \cdot 2H_2O$
Constants: Mol. Wt. 290.71
Density 2.229 @25°/25°C
Toxicity: See Fluogermanates and Hydroxylamine.

Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of fluorides.
Storage and Handling: Section 7

HYDROXYLAMINE FLUOSILICATE

Description: Scales.
Formula:
$2NH_2OH \cdot H_2SiF_6 \cdot 2H_2O$
Constant:
Mol. Wt. 246.17
Toxicity: See Fluosilicates and Hydroxylamine.
Disaster Control: Moderately dangerous; when heated to decomposition, or on contact with acid or acid fumes, it emits highly toxic fumes of fluorides.
Storage and Handling: Section 7

HYDROXYLAMINE HYDROCHLORIDE

Synonym: Hydroxylammonium chloride.
Description: Colorless, hygroscopic crystals.
Formula: $NH_2OH \cdot HCl$
Constants:
Mol. Wt. 69.50
M. P. 151°C
B. P. Decomposes
Density 1.67 @17°C
Toxicity: See Hydroxylamine and Hydrochloric Acid.
Disaster Control: Dangerous; on contact with acid or acid fumes, it can emit highly toxic fumes of chlorides.
Storage and Handling: Section 7

HYDROXYLAMINE NITRATE

Description: White crystals.
Formula: $NH_2OH \cdot HNO_3$
Constants:
Mol. Wt. 96.05
M. P. 48°C
B. P. < 100°C Decomposes
Toxicity: Highly toxic. See Hydroxylamine and Nitrates.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

HYDROXYLAMINE SULFATE. See Hydroxylamine Acid Sulfate.

HYDROXYL AMMONIUM ACID SULFATE

Description: A crystalline material.
Formula: $NH_2OH \cdot H_2SO_4$
Constants:
Mol. Wt. 131.1
M. P. Indefinite.
Toxicity: Highly toxic. See Hydroxylamine and Sulfuric Acid..
Explosion Hazard: Moderate, when exposed to heat or by chemical reaction. In the presence of alkalies at elevated temperatures, free hydroxylamine is liberated and may decompose explosively.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

HYDROXYLAMMONIUM CHLORIDE. See Hydroxylamine Hydrochloride.

HYDROXYMERCURICHLOROPHENOL

Description: Solid.
Formula: $C_6H_5ClHgO_2$
Constant:
Mol. Wt. 345.2
Toxicity: Highly toxic. See Mercury Compounds, Organic.
MCA warning label.

HYDROXYMERCURICRESOL

Formula: $HOHgC_6H_4OHCH_3$
Constant:
Mol. Wt. 325.8
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: See Mercury Compounds, Organic.
Storage and Handling: Section 7
Shipping Regulations. Section 11.
MCA warning label.

HYDROXYMERCURINITROPHENOL

Formula: $HOHgC_6H_4OHNO_2$
Constant:
Mol. Wt. 356.7
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates and Mercury Compounds, Organic.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
MCA warning label.

1-HYDROXY-4-METHYL-2, 6-DI-tert-BUTYL BENZENE. See Di -tert-Butyl-p-Cresol.

1-HYDROXYNAPHTHALENE. See a-Naphthol.

3-HYDROXY-2-NAPHTHOIC ACID
Synonyms: β-oxynaphthoic acid; 2-naphthol-3-carboxylic acid.
Description: Yellow needle-like crystals.
Formula: $HOC_{10}H_6COOH$
Constants:
Mol. Wt. 188.2
M. P. 216°C
Toxicity: Unknown
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

HYDROXYPENTAMETHYLFLAVAN
Synonym: 2-Hydroxy-2, 4, 4, 4, 7-pentamethylflavan.
Toxicity: Details unknown; an insecticide.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

o-HYDROXYPHENYLMERCURIC CHLORIDE
Synonym: o-Chloromercuriphenol.
Description: White to faint pink crystals.
Formula: $C_6H_4OHHgCl$
Constants: Mol. Wt. 329.2
M. P. 143.5°C
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: See Mercury Compounds, Organic.
Storage and Handling: Section 7

N-(2-HYDROXY PROPYL) ETHYLENE DIAMINE
Description: Colorless to faint yellow liquid.
Formula:
$H_2NCH_2CH_2NH(CH_2CHOHCH_3)$
Constants:
Mol. Wt. 118
B. P. 180° C @ 114 mm
Flash P. 254°F (C.O.C.)
Density 0.9858 @25°/25°C
Toxicity: Details unknown. See also Amines.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

3-HYDROXY PYRIDINE
Description: Tan-colored lumps.
Formula: C_5H_5ON
Constants:
Mol. Wt. 95.1
M. P. 126 - 129°C
B. P. 151 - 153°C @3 to 4 mm
Toxicity: Details unknown. See also Pyridine.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of nitrogen oxides; can react vigorously with oxidizing material.
Storage and Handling: Section 7

HYOSCINE
Synonym: Scopolamine.
Description: Thick, colorless, syrupy liquid alkaloid.
Formula: $C_{17}H_{21}NO_4$
Constants: Mol. Wt. 303.35
M. P. 55°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Toxicology: This material is a poisonous alkaloid. It can produce profound depression of the central nervous system and occasionally it causes excitement. It can cause hallucinations and the individual affected loses a certain amount of his normal inhibitory control. It is for that reason that it has been called "truth serum." In many cases of poisoning from this material, and even to a certain extent following its medical application, there is retention of the urine caused by paralysis of the bladder, and catheterization is necessary. The fatal dose is variable. Death has occurred from as little as 0.6 mg, while recovery has occurred from doses of 7 to 15 mg. There is even a reported case of recovery following a 500-mg ingestion of the hydrobromide by mouth.
Treatment and Antidotes: A physician

should be called at once. Wash the stomach with a large volume of warm water containing tannin, then give 15% magnesium sulfate (approximately 8 ounces). A solution of iodine may be used instead of tannin. Charcoal may also be used. If iodine is used, the amount should be roughly 4 times the weight of the atropine to be precipitated. The iodine solution should not be allowed to remain in the stomach. In moderate cases of poisoning, morphine is of advantage if given hypodermically. If the respiration is markedly depressed, caffeine and artificial respiration should be employed. Coramine may also be of value. If there is extreme excitement or violent delirium, chloroform or ether may be employed.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of nitrogen oxides.

Ventilation Control (use moderate rate): Section 2

Personal Hygiene: Section 3

Storage and Handling: Section 7

HYOSCINE HYDROBROMIDE. See Hyoscine.

HYOSCINE SULFATE. See Hyoscine.

HYOSCYAMINE

Synonyms: l-Hyoscyamine; duturine; duboisine.

Description: White crystalline alkaloid.

Formula: $C_{17}H_{23}NO_3$

Constants:
- Mol. Wt. 289.36
- M. P. 106 - 108°C

Toxic Hazard Rating:
- Acute Local: U
- Acute Systemic: Ingestion 3; Inhalation 3
- Chronic Local: U
- Chronic Systemic: U

Toxicology: This is one of the atropine alkaloids and is very toxic, acting very much like atropine. It has the same effect on the central nervous system but twice the effect on the peripheral nerves. The symptoms of poisoning from this material are those of dryness of the throat and mouth, marked difficulty in swallowing, and a sensation of burning and thirst. The vision becomes impaired through dilation and loss of accommodation, and the eyes present a rather prominent, brilliant, staring appearance. The voice is husky and the tongue is red.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of nitrogen oxides.

Ventilation Control (use moderate rate): Section 2

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

HYOSCYAMINE HYDROBROMIDE. See Hyoscyamine.

HYOSCYAMINE HYDROCHLORIDE. See Hyoscyamine.

HYOSCYAMINE SULFATE. See Hyoscyamine.

HYPOBROMOUS ACID

Description: Colorless to yellow solution.

Formula: HBrO

Constants:
- Mol. Wt. 96.92
- M. P. 40°C (in vacuum)

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: Ingestion 2; Inhalation 2

Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of bromides; will react with water or steam to produce toxic and corrosive fumes.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

HYPOCHLORITES

Description: Salts of hypochlorous acid.

Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, by chemical reaction with reducing agents. These are powerful oxidizers particularly at higher temperatures when chlorine and then oxygen are evolved, or in the presence of moisture or carbon dioxide.
Disaster Control: Dangerous; when heated or on contact with acid or acid fumes, it emits highly toxic fumes of chlorine and chlorides; will react with water or steam to produce toxic and corrosive fumes; it can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

HYPOCHLORITE SOLUTIONS CONTAINING MORE THAN 7% AVAILABLE CHLORINE BY WEIGHT. See Hypochlorites.
Shipping Regulations: Section 11.
  I. C. C. Classification: Corrosive liquid; white label.
  Coast Guard Classification: Corrosive liquid; white label.

HYPOCHLOROUS ACID. See Hypochlorites.

HYPOIODOUS ACID
Synonym: Iodine hydroxide.
Description: Yellow to greenish solution.
Formula: HOI
Constant: Mol. Wt. 143.93
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: Ingestion 2; Inhalation 2
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of iodides; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

HYPONITROUS ACID
Description: White solid.
Formula: $H_2N_2O_2$
Constants:
  Mol. Wt. 62.03
  M. P. Explodes
Toxicity: Details unknown. See also Nitric Oxide.
Fire Hazard: Unknown
Explosion: Severe, when exposed to heat or flame.
Disaster Control: Highly dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen and may explode.
Storage and Handling: Section 7

HYPOPHOSPHITES
Description: Salts of hypophosphorous acid.
Formula: $(H_2PO_2)^-$
Toxicity: Details unknown; generally have little or no toxicity.
Fire Hazard: Moderate, when exposed to heat (Section 6).
Explosion Hazard: Moderate, when exposed to heat. See also Phosphine.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosphine and oxides of phosphorous.
Storage and Handling: Section 7

HYPOPHOSPHORIC ACID
Description: Crystals.
Formula: $H_4P_2O_6$
Constants:
  Mol. Wt. 161.99
  M. P. 55°C
  B. P. Decomposes @100°C
Toxicity: Details unknown. See also Phosphoric Acid.
Explosion Hazard: Moderate, when exposed to heat.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of phosphorus.
Storage and Handling: Section 7

HYPOPHOSPHOROUS ACID

Description: Colorless, oily liquid or deliquescent crystals.

Formula: $H(H_2PO_2)$

Constants:

Mol. Wt. 66.00
M. P. 26.5°C
B. P. Decomposes
Density 1.493 @19°C

Toxicity: Details unknown. See also Phosphoric Acid.

Fire Hazard: Moderate; will react violently with oxidizing agents.

Disaster Control: Dangerous; on decomposition it emits highly toxic fumes of phosphine and may explode. Keep away from oxidizing agents.

Storage and Handling: Section 7

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ICTHYOL

Description: Thick brown liquid, bituminous odor.

Toxic Hazard Rating:

Acute Local: Irritant 1; Allergen 1; Ingestion 1

Acute Systemic: U

Chronic Local: Allergen 1

Chronic Systemic: U

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).

Personal Hygiene: Section 3

Storage and Handling: Section 7

ILLUMINATING GAS. See Carbon Monoxide and Methane.

3, 3'-IMINO-BIS-PROPYLAMINE

Description: Colorless liquid.

Formula: $C_6H_{17}N_3$

Constants:

Mol. Wt. 131.23

M. P. −14.5 °C

B. P. 151 °C @ 5 mm

Flash P. > 175 °F (C.C.)

Density 0.9237 g/cc @ 25 °C

Vap. D. 4.52

Toxic Hazard Rating:

Acute Local: Irritant 2; Ingestion 2; Inhalation 2

Acute Systemic: U

Chronic Local: U

Chronic Systemic: U

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

IMINO DIPROPIONITRILE

Description: Colorless liquid.

Formula: $HN(CH_2CH_2CN)_2$

Constants:

Mol. Wt. 123.16

M. P. −5.50 °C

B. P. 173° @ 10 mm

Density 1.0165 @ 30 °C

Toxicity: Highly toxic. See Cyanides.

Disaster Control: See Cyanides.

Storage and Handling: Section 7

INDIUM

Description: Tetragonal, silvery-white, soft metal.

Formula: In

Constants:

At. Wt. 114.76

M. P. 155 °C

B. P. 2000 °C

Density 7.28 @ 20 °C

Toxic Hazard Rating:

Acute Local: Irritant 2

Acute Systemic: Ingestion 3; Inhalation 3

Chronic Local: U

Chronic Systemic: U

Toxicology: When this material is injected into animals either subcutaneously or intravenously, it is found to be highly toxic. It affects the liver, the heart, the kidneys and the blood. However, available data are scanty. Toxicity is based on animal experiments (Section 1).

Radiation Hazard (Section 5): Artificial isotope In^{114}, half-life: 50 days; emits gamma rays of 0.192 mev. In^{114} decays to an isomeric form of short half-life (72 seconds) which has a beta emission of 2.0 mev.

Fire Hazard: Moderate in the form of dust when exposed to heat or flame (Section 6).

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

INDIUM CYANIDE
Description: White precipitate.
Formula: $In(CN)_3$
Constant:
Mol. Wt. 192.81
Toxicity: Highly toxic. See Cyanides.
Fire Hazard: See Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

INDIUM DIBROMIDE
Description: Pale-yellow solid.
Formula: $InBr_2$
Constants:
Mol. Wt. 274.6
M. P. 235°C
B. P. 632°C Sublimes
Density 4.22 @25°C
Toxicity: See Indium and Bromides.
Disaster Control: See Bromides.
Storage and Handling: Section 7

INDIUM DICHLORIDE
Description: White powder.
Formula: $InCl_2$
Constants:
Mol. Wt. 185.7
M. P. 235°C
B. P. 550 - 570°C
Density 3.655 @25°C
Toxicity: See Indium.
Disaster Control: See Chlorides.
Storage and Handling: Section 7

INDIUM DIHYDROGEN SULFATE
Description: Powder.
Formula: $In_2(SO_4)_3 \cdot H_2SO_4 \cdot 7H_2O$
Constants:
Mol. Wt. 741.9
M. P. $-H_2SO_4 \cdot 7H_2O$ @250°C
Toxicity: See Indium.
Disaster Control: See Sulfates.
Storage and Handling: Section 7

INDIUM DIIODIDE
Description: Solid.
Formula: InI_2
Constants:
Mol. Wt. 368.6
M. P. 212°C
Density 4.71 @25°C
Toxicity: See Indium.
Disaster Control: See Iodides.
Storage and Handling: Section 7

INDIUM FLUORIDE
Description: Solid.
Formula: InF_3
Constants:
Mol. Wt. 171.8
M. P. 1170 ± 10°C
B. P. > 1200°C
Density 4.39 ± 0.01 @25°C
Toxicity: See Indium and Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

INDIUM HYDROXIDE
Description: White precipitate.
Formula: $In(OH)_3$
Constants:
Mol. Wt. 165.78
M. P. $-H_2O < 150$°C
Toxicity: See Indium.

INDIUM IODATE
Description: White crystals.
Formula: $In(IO_3)_3$
Constants: Mol. Wt. 639.52
B. P. Decomposes
Toxicity: See Indium and Iodates.
Fire Hazard: Moderate, by chemical reaction with reducing agents (Section 6). A powerful oxidizing agent.
Explosion Hazard: Unknown
Disaster Control: Moderately dangerous; keep away from reducing agents.
Storage and Handling: Section 7

INDIUM MONOBROMIDE
Description: Red-brown crystals.
Formula: InBr
Constants:
Mol. Wt. 194.7
M. P. 220°C
B. P. 662°C Sublimes
Density 4.96
Toxicity: See Indium and Bromides.
Disaster Control: See Bromides.
Storage and Handling: Section 7

INDIUM MONOCHLORIDE
Description: White powder.
Formula: InCl
Constants:
Mol. Wt. 150.2
M. P. 225°C
B. P. 550°C
Density 4.18 (red); 4.19 (yellow) @25°C
Toxicity: See Indium and Chlorides.
Disaster Control: See Chlorides.
Storage and Handling: Section 7

INDIUM MONOIODIDE
Description: Brown-red solid.
Formula: InI
Constants:
Mol. Wt. 241.7
M. P. 351°C
B. P. 714°C
Density 5.31
Toxicity: See Indium and Iodides.

INDIUM MONOOXIDE
Description: Gray-white crystals.
Formula: InO
Constant:
Mol. Wt. 130.8
Toxicity: See Indium

INDIUM MONOSULFIDE
Description: Dark crystals.
Formula: InS
Constants:
Mol. Wt. 146.8
M. P. 692°C
B. P. 850°C
Density 5.18 @25°C
Toxicity: See Indium and Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

INDIUM PERCHLORATE
Description: Colorless, deliquescent crystals.
Formula: $In(ClO_4)_3 \cdot 8H_2O$
Constants:
Mol. Wt. 557.26
M. P. Ca. 80°C
B. P. D. 200°C
Toxicity: See Indium and Perchlorates.
Fire Hazard: Moderate. A powerful oxidizing agent. See Perchlorates.
Explosion Hazard: Moderate. See Perchlorates.
Disaster Control: Highly dangerous. See Perchlorates.

INDIUM SELENATE
Description: Deliquescent crystals.
Formula: $In_2(SeO_4)_3 \cdot 10H_2O$
Constant:
Mol. Wt. 838.56
Toxicity: See Selenium and Indium
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

INDIUM SESQUIOXIDE
Description: Red-brown crystals.
Formula: In_2O_3
Constants:
Mol. Wt. 277.5
M. P. 850°C Decomposes
Density 7.179
Toxicity: See Indium.

INDIUM SESQUISULFIDE
Description: Yellow crystals.
Formula: In_2S_3
Constants:
Mol. Wt. 325.7
M. P. 1050°C
B. P. Subl. @850°C in high vacuum
Density 4.90 @25°C
Toxicity: See Sulfides and Indium.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

INDIUM SUBOXIDE
Description: Black crystals.
Formula: In_2O
Constants: Mol. Wt. 245.5
Density 6.99 @25°C
M. P. Sublimes in Vacuum @656°C
Toxicity: See Indium

INDIUM SUBSULFIDE
Description: Yellow to black needles.
Formula: In_2S
Constants: Mol. Wt. 261.6
M. P. 653°C
Density 5.87 @25°C
Toxicity: See Sulfides and Indium.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

INDIUM SULFATE
Description: Grayish, deliquescent powder.
Formula: $In_2(SO_4)_3$
Constants:
Mol. Wt. 517.7
Density 3.438
Toxicity: See Indium.
Disaster Control: Moderately dangerous; when heated to decomposition, it evolves toxic fumes of sulfur oxides.
Storage and Handling: Section 7

INDIUM SULFITE, BASIC
Description: Crystals.
Formula: $2In_2O_3 \cdot 3SO_2 \cdot 8H_2O$
Constants:
 Mol. Wt. 891.37
 M. P. $-3H_2O$ @100°C
Toxicity: See Indium Compounds and Sulfites.
Disaster Control: Moderately dangerous; when heated to decomposition, it evolves toxic fumes of sulfur oxides.
Storage and Handling: Section 7

INDIUM TRIBROMIDE
Description: White to yellow needle-like crystals.
Formula: $InBr_3$
Constants:
 Mol. Wt. 354.5
 M. P. 436°C
 B. P. Sublimes
 Density 4.74 @25°C
Toxicity: See Indium and Bromides.
Disaster Control: See Bromides.
Storage and Handling: Section 7

INDIUM TRICHLORIDE
Description: White powder.
Formula: $InCl_3$
Constants:
 Mol. Wt. 221.1
 M. P. 586°C
 B. P. Volat. @600°C
 Density 3.46
Toxicity: See Indium.
Disaster Control: See Chlorides.
Storage and Handling: Section 7

INDIUM TRIIODIDE
Description: Yellow, deliquescent crystals.
Formula: InI_3
Constants:
 Mol. Wt. 495.5
 M. P. 210°C
 Density 4.69
Toxicity: See Indium and Iodides.
Disaster Control: See Iodides.
Storage and Handling: Section 7

INDOCENE
Constants:
 B. P. 340°F
 Flash P. 170°F (C.C.)
 Density 1.064
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Storage and Handling: Section 7

2(3)-INDOLONE
Synonym: Oxindole.
Description: Colorless, needle-like crystals.
Formula: $\underbrace{C_6H_4NHCOC}H_2$
Constants:
 Mol. Wt. 133.1
 M. P. 120°C
 B. P. Decomposes
 Flash P. 205 - 275°F
 Density 1.058 @20°/20°C
Toxicity: Details unknown, but probably toxic; an insecticide.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

INK, PRINTING
Description: Liquid or paste.
Composition: Carbon, black dye, glue, gum arabic, solvent.
Toxicity: Slight, due to solvent or dye used.
Fire Hazard: Dangerous, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Variable.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
 I.C.C. Classification: Flammable liquid; red label.
 Coast Guard Classification: Combustible liquid.
 Coast Guard Classification: Inflammable liquid; red label.

INSECTICIDE LIQUID GAS. See specific Components.
Shipping Regulations: Section 11.
 I.C.C. Classification: Nonflammable gas; green label.
 Coast Guard Classification: Noninflammable gas; green label.

INSECTICIDES, DRY. See specific Components listed on container.
Shipping Regulations: Section 11.
 I.C.C. Classification: Poison B; poison label.

Coast Guard Classification:
Poison B; poison label.

INSECTICIDES, LIQUID. See specific Components.
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label. Poison B; poison label (Vermin Exterminator).
Coast Guard Classification: Combustible liquid. Inflammable liquid; red label. Poison B; poison label (Vermin Exterminator).

INSTANTANEOUS FUSE. See Explosives, High.
Shipping Regulations: Section 11.
I. C. C. Classification: Explosive C - No Exemption.
Coast Guard Classification: Explosive C.

IODATES
Toxicity: Variable; similar to bromates and chlorates. See also specific compound.
Fire Hazard: These materials are a moderate fire hazard because they are powerful oxidizers. In contact with flammable or even combustible materials they can start fires (Section 6).
Disaster Control: Dangerous; when heated to decomposition, these compounds emit highly toxic fumes of iodine and iodine compounds; they can react vigorously with reducing materials.
Storage and Handling: Section 7

IODIC ACID
Description: Colorless to pale yellow crystals.
Formula: HIO_3
Constants:
Mol. Wt. 175.9
M. P. 110°C
Density 4.629
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: See Iodates.
Explosion Hazard: Unknown
Disaster Control: See Iodates.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

IODIC META-PERACID
Description: Rhombic, colorless to pale yellow crystals.
Formula: HIO_4
Constants:
Mol. Wt. 191.9
B. P. Sublimes @110°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3;
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: See Periodates.
Explosion Hazard: See Periodates.
Disaster Control: See Periodates.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

IODIC o-p-**PERACID**
Description: Powder.
Formula: H_5IO_6
Constants:
Mol. Wt. 228.0
M. P. Decomp. @140°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, by chemical reaction. A powerful oxidizer (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of iodine and iodine compounds; can react vigorously with reducing materials.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

IODIDES
Toxic Hazard Rating:
Acute Local: Variable.
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
Toxicology: Similar in toxicity to bromides. Prolonged absorption

of iodides may produce "Iodism" which is manifested by skin rash, running nose, headache and irritation of mucous membranes. In severe cases the skin may show pimples, boils, redness, black and blue spots, hives and blisters (Section 9). Weakness, anemia, loss of weight and general depression may occur.
Disaster Control: When heated to decomposition, they can emit highly toxic fumes of iodine and iodine compounds.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3

IODINE

Description: Rhombic, violet-black crystals, metallic luster.
Formula: I_2
Constants:
At. Wt. 253.84
M. P. 112.9°C
B. P. 183°C
Density 4.93
Vap. Press. 1 mm @38.7°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3
MAC: ACGIH (accepted); 1 part per million in air; 10 milligrams per cubic meter of air.
Toxicology: The effect of iodine vapor upon the body is similar to that of chlorine and bromine, but it is more irritating to the lungs. Serious exposures are seldom encountered in industry, due to the low volatility of the solid at ordinary room temperatures. Signs and symptoms are irritation and burning of the eyes, lachrymation, cough, irritation of the nose and throat.
Radiation Hazard (Section 5): Artificial isotope I^{131}, half-life: 8.0 days; emits beta particles of 0.32 mev (15%) and 0.60 mev (85%) and gamma rays of 0.08, 0.28, 0.36 and 0.64 mev. The permissible levels are: in body: 0.3 microcurie; in air: 3×10^{-9} microcurie per milliliter; in water: 3×10^{-5} microcurie per milliliter.

I^{131} concentrates in the thyroid, which is a relatively small organ. For this reason the permissible body level is quite low. Diagnostic and therapeutic doses of I^{131} used for diseases of the thyroid frequently run considerably above the maximum permissible level given in the table. Hazard Rating, Class II (National Bureau of Standards Handbook No. 42).
Disaster Control: Dangerous; when heated, it emits highly toxic fumes of iodine and iodine compounds; can react vigorously with reducing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

IODINE ACIDS

Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, they can emit highly toxic fumes of iodine and iodine compounds; they react with water or steam to produce corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

IODINE AZIDE

Description: Yellow crystals.
Formula: IN_3
Constant:
Mol. Wt. 168.94
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: Irritant 3; Ingestion 3; Inhalation 3
Chronic Systemic: U

Explosion Hazard: Severe, when shocked or exposed to heat (Section 7).
Disaster Control: Highly dangerous; shock and heat will explode it; when heated to decomposition, it emits highly toxic fumes of iodine and iodine acids.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

IODINE CYANIDE

Synonym: Cyanogen iodide.
Description: Colorless needles, very pungent odor, acrid taste.
Formula: ICN
Constants:
  Mol. Wt. 152.94
  M. P. 146.5°C
Toxicity: Highly toxic. See Iodine and Cyanides.
Disaster Control: See Iodine and Cyanides.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

IODINE HEPTAFLUORIDE

Description: Colorless crystals or liquid.
Formula: IF_7
Constants:
  Mol. Wt. 259.92
  M. P. 5.5°C
  B. P. Sublimes
  Density 2.8 @ 6°C (as liquid)
Toxicity: Highly toxic. See Iodine and Fluorides.
Explosion Hazard: Moderate, when exposed to heat (Section 7).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of iodine and fluorides, and may explode; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3

IODINE MONOBROMIDE

Description: Dark gray crystals.
Formula: IBr
Constants:
  Mol. Wt. 206.84
  M. P. 42°C; Sublimes @ 50°C
  B. P. 116°C
  Density 4.4157 @ 0°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Explosion Hazard: Moderate, when exposed to heat (Section 9).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromine, iodine and their compounds; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

β-IODINE MONOCHLORIDE

Synonyms: α-Iodine monochloride.
Description: Reddish-brown, oily liquid.
Formula: ICl
Constants:
  Mol. Wt. 162.4
  M. P. alpha 27°C; beta 14°C
Toxicity: Highly toxic. See Iodine and Chlorine.
Explosion Hazard: Moderate, when exposed to heat.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorine and iodine, and may explode; will react with water or steam, to produce toxic and corrosive fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

IODINE NONOXIDE

Description: Yellow, hygroscopic powder.
Formula: I_4O_9
Constants:
  Mol. Wt. 651.7
  M. P. 75°C Decomposes.
Toxicity: Highly toxic. See Iodine.

Fire Hazard: Moderate, by spontaneous chemical reaction. A powerful oxidizing agent (Section 6).
Explosion Hazard: Moderate, when exposed to heat.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of iodine and iodine compounds, and may explode; can react vigorously with reducing materials.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

IODINE OXIDE

Synonyms: Iodine dioxide; iodine tetroxide.
Description: Lemon-yellow crystals.
Formula: IO_2
Constants:
Mol. Wt. 158.9
M. P. Decomp. slowly @ 75°C; rapidly @ 130°C
Density 4.2 @ 10°/10°C
Toxicity: Highly toxic. See Iodine.
Fire Hazard: Moderate; by spontaneous chemical reaction. An oxidizing agent (Section 6).
Explosion Hazard: Slight, when exposed to heat.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of iodine and iodine compounds; can react vigorously with reducing materials.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

IODINE PENTABROMIDE

Description: Crystals.
Formula: IBr_5
Constant:
Mol. Wt. 526.5
Toxicity: Highly toxic. See Iodine and Bromine.
Fire Hazard: Dangerous, by spontaneous chemical reaction (Section 6).
Explosion Hazard: Slight, when exposed to heat or flame.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromine, iodine and their compounds; will react with water or steam to produce toxic and corrosive fumes; can react vigorously with reducing materials.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

IODINE PENTAFLUORIDE

Description: Colorless liquid.
Formula: IF_5
Constants:
Mol. Wt. 221.9
M. P. −8.0°C
B. P. 97°C
Density 3.5
Vap. Press 10 mm @ 8.5°C
Toxicity: Highly toxic. See Iodine and Fluorides.
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of iodine, fluorine and their compounds; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

IODINE PENTOXIDE

Description: White crystals.
Formula: I_2O_5
Constants:
Mol. Wt. 333.8
M. P. 300 - 350°C
Density 4.799 @ 25°C
Toxicity: Highly toxic. See Iodine.
Fire Hazard: Dangerous, by spontaneous chemical reaction (Section 6).
Caution: A powerful oxidizing agent.
Explosion Hazard: Slight, when exposed to heat or flame.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of iodine and iodine compounds; will react with water or steam to produce toxic fumes; can react vigorously with reducing materials.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

IODINE TRIBROMIDE

Description: Dark brown liquid.
Formula: IBr_3
Constant: Mol. Wt. 366.7

Toxicity: See Iodine and Bromine.
Fire Hazard: Moderate, by spontaneous chemical reaction (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of bromine, iodine and compounds of each and explodes; will react with water or steam to produce toxic and corrosive fumes; can react vigorously with reducing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

IODINE TRICHLORIDE

Description: Orange-yellow, deliquescent, crystalline powder; pungent, irritating odor.
Formula: ICl_3
Constants:
Mol. Wt. 233.29
M. P. 101°C @16 atm.
B. P. Decomposes @77°C
Density 3.117
Toxicity: Highly toxic. See Iodine and Chlorine.
Explosion Hazard: Slight, when exposed to heat or flame.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of iodine and chlorine and compounds of each; will react with water or steam to produce toxic and corrosive fumes; can react with reducing materials.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

IODOPLATINIC ACID

Description: Monoclinic, black, deliquescent crystals.
Formula: $H_2PtI_6 \cdot 9H_2O$
Constants:
Mol. Wt. 1120.91
M. P. <100°C
Toxicity: Highly toxic. See Iodine and Platinum Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of iodine and iodine compounds.
Storage and Handling: Section 7

IODOSUCCINIMIDE

Synonym: NIS.
Description: Off-white, nearly odorless powder.
Formula: $C_4H_4O_2NI$
Constants:
Mol. Wt. 225.0
M. P. 201°C
Toxicity: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, or in the presence or in the presence of acid or acid fumes, it can emit toxic fumes of nitrogen and sulfur compounds.
Storage and Handling: Section 7

IODOUS HYPOACID

Synonym: Iodine hydroxide.
Description: Yellow to greenish solution.
Formula: HOI
Constant:
Mol. Wt. 143.9
Toxicity: Details unknown. See also Iodine and Iodides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of iodine and iodine compounds.
Storage and Handling: Section 7

IPECAC

Synonym: Ipecacuanha.
Description: Dried rhizome and roots of Rio or Brazilian ipecac.
Composition: Emetine, cephaeline, emetamine, ipecacuanic acid, psychotrine, methyl psychotaine, resin.
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3
Chronic Local: U
Chronic Systemic: Ingestion 1
Caution: Can cause conjunctivitis with opacity of the cornea. See also Emetine.
Personal Hygiene: Section 3
Storage and Handling: Section 7

IRIDIUM AND IRIDIUM COMPOUNDS

Description: Silver-white metal.
Formula: Ir
Constants:
At. Wt. 193.10

M. P. 2440 ± 15°C
B. P. 4400°C
Density 22.421
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Toxicology: Soluble iridium compounds are said to be toxic. However, there are no industrial data available upon which to base a maximum allowable concentration in air.
Radiation Hazard (Section 5): Artificial isotope Ir^{190}, half-life: 10.7 days; emits beta particles of 0.09 mev and gamma rays of 0.25 mev. The permissible levels are: in body: 21 microcuries; in air: 7×10^{-7} microcurie per milliliter; in water: 10^{-2} microcurie per milliliter. Artificial isotope Ir^{192}, half-life: 70 days; emits beta particles of 0.65 mev and many gamma rays between 0.14 - 0.65 mev. The permissible levels are: in body: 3.4 microcuries per milliliter; in air: 5×10^{-8} microcurie per milliliter; in water: 9×10^{-4} microcurie per milliliter.
Fire Hazard: Moderate, in the form of dust when exposed to heat or flame. See also Powdered Metals.
To Fight Fire: Special mixtures of dry chemical (Section 6).
Explosion Hazard: Moderate in the form of dust when exposed to flame. See also Powdered Metals.
Ventialtion Control (use normal rate): Section 2
Personal Hygiene: Section 3

IROKO

Description: A wood.
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: 0
Chronic Local: Allergen 1
Chronic Systemic: 0
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: Moderate, in the form of dust when exposed to heat or flame (Section 7).
Personal Hygiene: Section 3

IRON

Synonym: Ferrum.
Description: Silvery-white, tenacious, lustrous, ductile metal.
Formula: Fe
Constants:
At. Wt. 55.8
M. P. 1535°C
B. P. 3000°C
Density 7.86
Vap. Press. 1 mm @ 1787°C
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Inhalation 1
Chronic Local: 0
Chronic Systemic: Inhalation 1
MAC: ACGIH (accepted); 15 milligrams per cubic meter of air (as oxide fume).
Toxicology: Iron dust can cause conjunctivitis, choroiditis, retinitis and siderosis of tissues if iron remains in these tissues. Iron ore dust can cause palpebral conjunctivitis. The mottling of the lungs which has been found in personnel who have been exposed to iron dust or iron oxide fumes in the mining or welding industries is now believed to be a benign condition, which does not predispose the worker to tuberculosis nor impair his ability to work. Also, it is thought that it takes 6 to 10 years to bring this condition about, and then only if the exposure has been severe for that period. An iron oxide fume is generated in welding operations and continued exposure to concentrations above 30 mg/cu meter of air can cause chronic bronchitis. Fresh iron oxide fume can cause metal fume fever.
Radiation Hazard (Section 5): Artificial isotope Fe^{55}, half-life: 2.9 years; emits low energy gamma and x-rays. The permissible levels are: in body: 10^3 microcuries; in air: 6×10^{-7} microcurie per milliliter; in water: 4×10^{-3} microcurie per milliliter. Fe^{59} represents considerable internal radiation hazard. Any iron uptake in the body becomes part of the hemoglobin and is not readily eliminated. Being directly in the blood, the isotope may cause

considerable damage to the blood forming organs. Hazard Rating, Class III (National Bureau of Standards Handbook No. 42). Artificial isotope Fe^{59}, half-life 46.3 days; emits beta particles of 0.26 mev (50%) and 0.46 mev (50%) and gamma rays of 1.1 and 1.3 mev. The permissible levels are: in body: 11 microcuries; in air: 1.5×10^{-8} microcurie per milliliter; in water: 1×10^{-4} microcurie per milliliter. See Fe^{55}. Hazard Rating, Class II (National Bureau of Standards Handbook No. 42).
Fire Hazard: Moderate in the form of dust when exposed to heat or flame. See also Powdered Metals.
To Fight Fire: Special mixtures of dry chemical (Section 6).
Explosion Hazard: Moderate, in the form of dust when exposed to heat or flame. See also Powdered Metals.
Personal Hygiene: Section 3

IRON BORIDE
Description: Gray crystals.
Formula: FeB
Constant:
Mol. Wt. 66.67
Toxicity: Details unknown.
Fire Hazard: Moderate. Borides can react with moisture and acids to yield boron hydrides.
Explosion Hazard: A possible explosion hazard.
Disaster Control: Moderate; can react with water, steam or acids to evolve toxic and flammable fumes.
Storage and Handling: Section 7

IRON CARBONYL. See Iron Pentacarbonyl.

IRON COMPOUNDS. See corresponding Ferric and/or Ferrous Compound.

IRON MASS, SPENT. See Iron Sponge, Spent.

IRON MONOPHOSPHIDE
Description: Rhombic crystals.
Formula: FeP
Constants:
Mol. Wt. 86.8
Density 5.2 @20°C
Toxicity: See Phosphides.
Fire Hazard: See Phosphides.
Explosion Hazard: See Phosphides.
Disaster Control: See Phosphides.
Storage and Handling: Section 7

IRON NONACARBONYL
Description: Orange, hexagonal crystals.
Formula: $Fe_2(CO)_9$
Constants:
Mol. Wt. 363.8
M. P. Decomp. @ 100°C
Density 2.085 @18°C
Toxicity: Highly toxic. See Carbon Monoxide.
Fire Hazard: See Carbonyls.
Explosion Hazard: See Carbonyls.
Disaster Control: See Carbonyls.
Storage and Handling: Section 7

IRON OXIDE. See Ferrous Oxide.
Shipping Regulations: Section 11.
Coast Guard Classification: Hazardous material (Wet).

IRON PENTACARBONYL
Description: Yellow to dark red liquid.
Formula: $Fe(CO)_5$
Constants:
Mol. Wt. 195.9
M. P. −21°C
B. P. 105.0°C
Flash P. 5°F
Density 1.453 @25°/4°C
Vap. Press. 40 mm @30.3°C
Toxicity: Highly toxic. See Carbonyls.
Fire Hazard: Dangerous. See Carbonyls.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate. See Carbonyls.
Disaster Control: See Carbonyls.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

IRON SPONGE (NOT PROPERLY OXIDIZED)
Toxicity: Details unknown. See also iron.

Fire Hazard: Dangerous, when exposed to heat or flame; it can react vigorously with oxidizing materials (Section 6).
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable solid; yellow label - not accepted.
  Coast Guard Classification: Inflammable solid; yellow label.

IRON SPONGE, SPENT

Composition: Iron + other materials.
Toxicity: Details unknown. See also Iron.
Fire Hazard: Dangerous, when exposed to heat or flame; it can react vigorously with oxidizing materials (Section 6).
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable solid; yellow label - not accepted.
  Coast Guard Classification: Inflammable solid; (Wet) Hazardous material.

IRON TETRACARBONYL

Description: Dark green, lustrous crystals.
Formula: $Fe(CO)_4$
Constants:
  Mol. Wt. 167.88
  M. P. Decomp. @140 - 150°C
  Density 1.996 @18°C
Toxicity: Highly toxic. See Carbonyls.
Fire Hazard: See Carbonyls.
Explosion Hazard: See Carbonyls.
Disaster Control: See Carbonyls.
Storage and Handling: Section 7

ISOAMYL ACETATE

Synonyms: Amyl acetate, iso; banana oil.
Description: Liquid, banana-like odor.
Formula: $CH_3COO(C_5H_{11})$
Constants:
  Mol. Wt. 130.2
  B. P. 142.0°C
  Flash P. 77°F
  Density 0.876
  Autoign. Temp. 715°F
  Vap. D. 4.49
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: Irritant 2
  Chronic Systemic: U
MAC: ACGIH (accepted); 200 parts per million in air; 1064 milligrams per cubic meter of air.
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with reducing materials (Section 6).
Underwriters Laboratory Classification: 55 - 60.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 1.0% @212°F.
Disaster Control: Dangerous; keep away from heat and open flame!
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ISOAMYL ALCOHOL, PRIMARY

Synonyms: Isobutyl carbinol; fusel oil.
Description: Clear liquid.
Formula: $(CH_3)_2CHCH_2CH_2OH$
Constants:
  Mol. Wt. 88.15
  B. P. 132°C
  Flash P. 109°F (C. C.)
  Density 0.813
  Autoign. Temp. 650°F
  Vap. D. 3.04
Toxicity: See Amyl Alcohol.
MAC: ACGIH (accepted); 100 parts per million in air; 360 milligrams per cubic meter of air.
Fire Hazard: Moderate, when exposed to heat or flame; can react vigorously with reducing materials.
Underwriters Laboratory Classification: 35 - 40
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Slight, when exposed to flame.
Explosive Range: 1.2% (L. E. L.)
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3

Personal Hygiene: Section 3
Storage and Handling: Section 7

ISOAMYL ALCOHOL, SECONDARY

Synonym: Isobutyl carbinol.
Formula: $(CH_3)_2CHCH(OH)CH_3$
Constants:
Mol. Wt. 88.15
B. P. 113°C
Flash P. 103°F (C.C.)
Density 0.819
Vap. D. 3.04
Toxicity: See Amyl Alcohol.
MAC: ACGIH (accepted); 100 parts per million in air; 360 milligrams per cubic meter of air.
Fire Hazard: Moderate, when exposed to heat or flame; can react vigorously with reducing materials (Section 6).
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ISOAMYL BROMIDE

Description: Colorless liquid.
Formula: $(CH_3)_2CHC_2H_4Br$
Constants: Mol. Wt. 151.1
B. P. 119.7 - 121.8°C
Flash P. 90°F
M. P. -112°C
Density 1.208 @25°/25°C
Vap. D. 5.25
Toxicity: Details unknown. See also Bromine Compounds.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of bromides; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

ISOAMYL BUTYRATE

Description: Water-white liquid.
Formula: $C_5H_{11}COOC_3H_7$
Constants: Mol. Wt. 158.23
B. P. 178.6°C
Density 0.866 - 0.868 @15.5°C
Vap. Press. 1 mm @21.2°C
Toxicity: Slight. See Butyric Acid.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Storage and Handling: Section 7

ISOAMYL DICHLOROARSINE

Description: Oily liquid, somewhat agreeable odor, decomposed by water.
Formula: $C_5H_{11}AsCl_2$
Constants:
Mol. Wt. 217.0
B. P. 88.5 - 91.5°C
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.

ISOAMYL FORMATE

Description: Clear liquid.
Formula: $C_5H_{11}OOCH$
Constants:
Mol. Wt. 116.16
B. P. 123.3°C
Density 0.87 @20°C
Vap. Press. 10 mm @17.1°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
Toxicology: This material is very irritating and can cause narcosis. The symptoms are usually transient in nature, but it is possible upon severe or prolonged exposure to have serious consequences.
Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ISOBORNYL THIOCYANOACETATE

Description: Yellow, oily liquid.
Formula: $C_{13}H_{19}NO_2S$
Constants:
Mol. Wt. 253.4
Density 1.1465 @25°/4°C

Toxicity: Probably slight. See also Thiocyanates. An insecticide and fly spray.
Disaster Control: See Thiocyanates.
Storage and Handling: Section 7

ISOBUTANE

Synonyms: 2-Methyl propane; trimethyl methane.
Description: Colorless gas.
Formula: C_4H_{10}
Constants:
Mol. Wt. 58.12
B. P. -11.7°C
Freezing P. -160°C
Density 0.5572 @20°C
Autoign Temp. 1010°F
Vap. D. 2.01
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Inhalation 1
Chronic Local: 0
Chronic Systemic: U
Caution: An asphyxiant.
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
To Fight Fire: Carbon dioxide, dry chemical or water spray (Section 6).
Explosion Hazard: Severe, when exposed to heat or flame.
Explosive Range: 1.9 - 8.5%.
Disaster Control: Dangerous; shock can shatter the compressed gas container with explosive force; on contact with oxidizing materials, it can react vigorously.
Ventilation Control (use moderate rate): Section 2

ISOBUTANOL. See Isobutyl Alcohol.

ISOBUTYL ACETATE

Description: Colorless, neutral liquid, fruit-like odor.
Formula: $C_4H_9OOCCH_3$
Constants:
Mol. Wt. 116.10
M. P. -98.9°C
B. P. 118.0°C
Flash P. 64°F (C.C.)
Density 0.8685 @15°C
Vap. Press. 10 mm @12.8°C
Vap. D. 4.00
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (accepted); 400 parts per million in air; 1896 milligrams per cubic meter of air.
Caution: Upon absorption it can hydrolyze to acetic acid and isobutanol.
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride.
Disaster Control: Dangerous! Keep away from heat and open flame!
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ISOBUTYL ALCOHOL

Synonyms: Isopropylcarbinol; 2-methyl propanol-1; isobutanol.
Description: Clear liquid, sweet odor.
Formula: $(CH_3)_2CHCH_2OH$
Constants:
Mol. Wt. 74.12
B. P. 107.90°C
Flash P. 100°F (C.O.C.)
Freezing P. -108°C
Density 0.805 @20°/4°C
Autoign. Temp. 800°F
Vap. Press. 10 mm @21.7°C
Vap. D. 2.55
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.
Underwriters Laboratory Classification: 40 - 45
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, in the form of vapor when exposed to heat or flame.
Explosive Range: 1.68% (L.E.L.)
Disaster Control: Moderately dangerous; emits highly toxic fumes when heated. Keep away from heat and open flame.

Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ISOBUTYL ALDEHYDE

Synonyms: Isobutyraldehyde; 2-methyl propanol.
Description: Transparent, colorless, highly refractive liquid; pungent odor.
Formula: $(CH_3)_2CHCHO$
Constants:
Mol. Wt. 72.10
M. P. -65.9°C
B. P. 64°C
Flash P. -40°F (C. C.)
Density 0.7938 @20°/4°C
Autoign. Temp. 490°F
Toxicity: See Aldehydes.
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate
Disaster Control: Dangerous; keep away from heat and open flame; can react vigorously with reducing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

ISOBUTYL AMINE

Synonym: 1-Amino-2-methylpropane.
Description: Colorless liquid.
Formula: $(CH_3)_2CHCH_2NH_2$
Constants:
Mol. Wt. 73.14
M. P. -85.5°C
B. P. 68.6°C
Flash P. 15°F
Density 0.731 @20°/20°C
Vap. Press. 100 mm @18.8°C
Toxicity: Details unknown. See Amines.
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Spontaneous Heating: No
To Fight Fire: Dry chemical, foam, carbon dioxide or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

ISOBUTYL BENZENE

Description: Liquid.
Formula: $C_4H_9C_6H_5$
Constants:
Mol. Wt. 134.23
M. P. -51.5°C
B. P. 172.8°C
Flash P. 126°F (C.C.)
Density 0.867
Autoign. Temp. 802°F
Vap. Press. 1 mm @14.1°C
Vap. D. 4.62
Toxicity: Details unknown. See also Benzene.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

ISOBUTYL BROMIDE

Description: Colorless liquid.
Formula: $(CH_3)_2CHCH_2Br$
Constants:
Mol. Wt. 137.0
M. P. -118.5°C
B. P. 91 - 93°C
Freezing P. < -30°C
Density 1.258 @25°/25°C
Vap. D. 4.76
Toxicity: Details unknown. See Bromides.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits highly toxic fumes of bromine; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

ISOBUTYL CARBINOL. See Isoamyl Alcohol.

ISOBUTYLENE

Synonyms: Isobutene; 2-methyl propene.

Description: Volatile liquid or easily liquefied gas.
Formula: $(CH_3)_2CCH_2$
Constants:
 Mol. Wt. 56.1
 B. P. −6.9°C
 Freezing P. −140.3°C
 Flash P. < 20°F
 Density 0.600
 Autoign. Temp. 869°F
 Vap. Press. 3290 mm @40.5°C
 Vap. D. 1.94
Toxicity: Details unknown. May have asphyxiant or narcotizing action.
Fire Hazard: Dangerous; when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ISOBUTYL ISOBUTYRATE

Description: Liquid with fruity odor.
Formula: $(CH_3)_2CHCOOCH_2CH(CH_3)_2$
Constants:
 Mol. Wt. 144.2
 M. P. −80.7°C
 B. P. 147.5°C
 Density 0.850-0.860 @20°/20°C
 Vap. Press. 10 mm @39.9°C
 Vap. D. 4.97
Toxicity: Details unknown; an insect repellent. See also Isobutyl Alcohol.
Fire Hazard: Slight, when exposed to heat or flame (Section 6); can react with oxidizing materials.
Storage and Handling: Section 7

ISOBUTYL METHYL KETONE

Synonyms: Methyl isobutyl ketone; hexone.
Description: Clear liquid.
Formula: $(CH_3)_2CHCH_2CH_3CO$
Constants:
 Mol. Wt. 100.2
 B. P. 118°C
 Flash P. 73°F
 Density 0.803
 Autoign. Temp. 858°F
 Vap. D. 3.45
Toxic Hazard Rating:
 Acute Local: Irritant 2; Ingestion 2; Inhalation 2
 Acute Systemic: Ingestion 3; Inhalation 3
 Chronic Local: U
 Chronic Systemic: U
MAC: ACGIH (accepted); 100 parts per million in air; 409 milligrams per cubic meter of air.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, in the form of vapor when exposed to heat or flame.
Explosive Range: 1.34%@122°F to 8.00% @212°F.
Disaster Control: Dangerous! Keep away from heat and open flame; can react vigorously with reducing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ISOBUTYL VINYL ETHER

Description: Liquid.
Formula: $C_4H_9OCHCH_2$
Constants:
 Mol. Wt. 100.2
 M. P. −112°C
 B. P. 82.9 - 83.2°C
 Flash P. 20°F
 Density 0.76 @25°/4°C
 Vap. D. 3.45
Toxicity: Details unknown. See Ethers.
Fire Hazard: Dangerous, when exposed to heat or flame. See Ethers.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Severe, when exposed to sparks or open flame. See Ethers.
Disaster Control: Dangerous! Keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

ISOBUTYRALDEHYDE

Description: Colorless liquid;

pungent odor.
Formula: $(CH_3)_2CHCHO$
Constants:
Mol. Wt. 72.06
M. P. -65.9°C
B. P. 64°C
Flash P. -40°F (C.C.)
Density 0.7938 @20°/4°C
Autoign. Temp. 490°F
Toxicity: Details unknown. See also Aldehydes.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, in the form of vapor when exposed to flame.
Disaster Control: Dangerous! Keep away from heat and open flame; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

ISOBUTYRIC ACID

Description: Colorless liquid, pungent odor.
Formula: $(CH_3)_2CHCOOH$
Constants:
Mol. Wt. 88.1
M. P. -47°C
B. P. 154.5°C
Flash P. 170°F (T.O.C.)
Density 0.949 @20°/4°C
Vap. Press. 1 mm @14.7°C
Vap. D. 3.04
Toxicity: Slight. See Butyric Acid.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ISOCINCHOMERONIC ACID

Description: Off-white powder.
Formula: $C_5H_3N(COOH)_2$
Constants:
Mol. Wt. 167.12
M. P. 240°C Decomposes
Toxicity: Unknown
Fire Hazard: Slight; when heated it emits acrid fumes.
Storage and Handling: Section 7

ISODECYL OCTYL ADIPATE

Description: Liquid, low viscosity, water white.
Formula:
$(C_{10}H_{21})(C_8H_{17})(CO_2)_2(CH_2)_4$
Constants:
Mol. Wt. 398.6
M. P. -60°C
B. P. 215 - 240°C @4 mm
Flash P. 400°F
Density 0.924 @20°/20°C
Vap. D. 13.8
Toxicity: Details unknown. See Adipic Acid.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

ISOFORM

Synonym: p-Iodoanisole.
Description: White powder.
Formula: $C_6H_4(OCH_3)IO_2$
Constant:
Mol. Wt. 265.98
Toxicity: Unknown
Disaster Control: Moderate, when heated, it emits highly toxic fumes of iodides; explodes at 225°C.
Storage and Handling: Section 7

ISOHEPTANE

Synonym: 2-Methyl hexane.
Description: Colorless liquid.
Formula: $(CH_3)_2CH(CH_2)_2CH_2CH_3$
Constants:
Mol. Wt. 100.2
B. P. 90°C
Freezing P. -119.1°C
Flash P. < 0°F
Density 0.6789
Vap. D. 3.45
Toxicity: Probably slight.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; keep away from heat and open flame; can react vigorously with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Storage and Handling: Section 7

ISOHEXANE

Synonym: Mixture of hexane isomers.

Description: Liquid.

Formula: C_6H_{14}

Constants:

Mol. Wt. 86.17

B. P. 130 - 140°F

Flash P. Below -20°F (C.C.)

Density 0.669

Vap. D. 3.00

Toxicity: See Hexane.

Fire Hazard: Dangerous, when exposed to heat or flame.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Severe, when exposed to heat or flame.

Explosive Range: 1.0 - 7.0%

Disaster Control: Dangerous! Keep away from sparks, heat or open flame; can react vigorously with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Storage and Handling: Section 7

ISOOCTANE

Synonyms: 2,2,4-Trimethyl pentane; 2-methyl heptane.

Description: Clear liquid.

Formula: $(CH_3)_2CH(CH_2)_4CH_3$

Constants:

Mol. Wt. 114.2

B. P. 99.2°C

Freezing P. -116°C

Flash P. 40°F

Density 0.703 @20°/4°C

Autoign. Temp. 986°F

Vap. Press. 40.6 mm @21°C

Vap. D. 3.93

Toxic Hazard Rating:

Acute Local: U

Acute Systemic: Ingestion 2; Inhalation 2

Chronic Local: U

Chronic Systemic: U

MAC: ACGIH (accepted); 500 parts per million in air; 2330 milligrams per cubic meter of air.

Fire Hazard: Dangerous, when exposed to heat or flame.

Spontaneous Heating: No

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Disaster Control: Dangerous; keep away from heat and open flame; can react vigorously with reducing materials.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations: Section 11.

I.C.C. Classification: Flammable liquid; red label.

Coast Guard Classification: Inflammable liquid; red label.

ISOOCTENES

Formula: C_8H_{16}

Constants:

Mol. Wt. 112.2

B. P. 102 - 107°C

Flash P. < 20°F

Density 0.723 @15.5°/15.5°C

Vap. Press. 102 mm @21°C

Vap. D. 3.9

Toxicity: Unknown

Fire Hazard: Dangerous; when exposed to heat or flame (Section 6).

Disaster Control: Dangerous; keep away from heat and open flame; can react vigorously with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Storage and Handling: Section 7

Shipping Regulations: Section 11.

I.C.C. Classification: Flammable liquid; red label.

Coast Guard Classification: Inflammable liquid; red label.

ISOOCTYL DECYL PHTHALATE

Description: Water-white, low viscosity liquid.

Formula: $C_{10}H_{21}O_2CC_6H_4CO_2C_8H_{17}$

Constants:

Mol. Wt. 418

B. P. 232 - 243°C @4 mm

Pour P. -43°C

Flash P. 455°F (C.O.C.)

Density 0.973 @20°C

Vap. D. 14.4

Toxicity: See Esters.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon

tetrachloride (Section 6).
Storage and Handling: Section 7

ISOOCTYL THIOGLYCOLATE

Description: A clear, water-white liquid, fruity odor.
Formula: $HSCH_2COOC_8H_{17}$
Constants:
Mol. Wt. 204.33
B. P. 125°F @17 mm
Density 0.9736 @25°C
Toxicity: Probably toxic. See Thioglycolic Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; will react with water or steam to produce toxic and flammable vapors; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

ISOPENTANE

Synonyms: 2-Methyl butane; isoamyl hydride.
Description: Colorless liquid with pleasant odor.
Formula: $CH_3CHCH_3CH_2CH_3$
Constants:
Mol. Wt. 72.15
B. P. 27.8°C
Freezing P. −160.5°C
Flash P. −60°F (C.C.)
Density 0.621 @20°/4°C
Autoign. Temp. 788°F
Vap. Press. 595 mm @21.1°C
Vap. D. 2.48
Toxicity: See Pentane.
Fire Hazard: Highly dangerous; when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous. Keep away from sparks, heat or open flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

ISOPHORONE

Description: Practically water-white liquid.
Formula: $COCHC(CH_3)CH_2C(CH_3)_2CH_2$
Constants:
Mol. Wt. 138.1
B. P. 215.2°C
Flash P. 205°F (O.C.)
Density 0.9229
Autoign. Temp. 864°F
Vap. Press. 1 mm @38.0°C
Vap. D. 4.77
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (accepted); 25 parts per million in air; 141 milligrams per cubic meter of air.
Toxicology: Considered to be more toxic than mesityl oxide. However, due to its low volatility, it is not a dangerous industrial hazard. The response of guinea pigs and rats to repeated inhalations of the vapors indicates that it is one of the most toxic of the ketones. It is chiefly a kidney poison. It can cause irritation, lachrymation, possible opacity of the cornea and necrosis of the cornea (experimental). It is irritant at the level of 25 ppm to humans. In animal experiments death during exposure was usually due to narcosis, but occasionally to irritation of the lungs.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ISOPRENE

Synonym: 3-Methyl 1,3-butadiene.
Description: Colorless, volatile liquid.
Formula: $CH_2C(CH_3)CHCH_2$
Constants: Mol. Wt. 68.11
M. P. −146.7°C
B. P. 34°C
Flash P. −65°F (C.C.)
Density 0.6806 @20°/4°C

Autoign. Temp. 428°F
Vap. Press. 400 mm @15.4°C
Vap. D. 2.35
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Inhalation 2
Chronic Local: U
Chronic Systemic: U
Toxicology: Isoprene is irritant to mucous membranes of the eyes, nose and upper respiratory passages. Concentrations of 2 percent in air do not narcotize mice but produce bronchial irritation. Concentrations of 5 percent are fatal to mice. There are no data on human exposures.
Fire Hazard: Highly dangerous; when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; keep away from sparks, heat or open flame; can react vigorously with reducing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

ISOPROPANOL. See Isopropyl Alcohol.

ISOPROPANOLAMINES, MIXED

Description: Clear liquid.
Formula: $CH_3CH(OH)CH_2NH_2$
Constants:
Mol. Wt. 75.1
M. P. 29.5°C
B. P. 159°C
Flash P. 160°F (O.C.)
Density 0.962
Vap. D. 2.58
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

ISOPROPENYL ACETATE

Description: Water-white liquid.
Formula: $CH_3COOC(CH_3)CH_2$
Constants:
Mol. Wt. 100.06
M. P. 92.9°C
B. P. 96.6°C @746 mm
Flash P. 60°F (O.C.)
Density 0.9226 @20°/20°C
Vap. D. 3.45
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous! Keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

ISOPROPENYL CHLOROFORMATE

Description: Liquid.
Formula: $CH_3COCOClCH_2$
Constants:
Mol. Wt. 120.5°C
B. P. 93°C @746 mm
Density 1.103 @20°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition it emits toxic fumes of chlorides.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3

Personal Hygiene: Section 3
Storage and Handling: Section 7

β- ISOPROPOXYPROPIONITRILE

Description: Liquid.
Formula: $C_3H_7OCH_2CH_2CN$
Constants:
  Mol. Wt. 113.16
  M. P. -67°C
  B. P. 82 - 86°C
  Flash P. > 100°F
  Density 0.9058
  Vap. D. 3.91
Toxicity: Highly toxic. See Cyanides.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of cyanides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

3- ISOPROPOXYPROPYLAMINE

Synonym: 3-Dimethylcarbinolpropylamine.
Description: Colorless liquid.
Formula: $(CH_3)_2CHOCH_2CH_2CH_2NH_2$
Constants:
  Mol. Wt. 118.2
  B. P. 147°C
  Density 0.845 @20°/20°C
  Vap. D. 4.07
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: Inhalation 3
  Chronic Systemic: U
Disaster Control: Dangerous; when heated, it emits toxic fumes; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ISOPROPYL ACETATE

Description: Colorless aromatic liquid.
Formula: $CH_3COOCH(CH_3)_2$
Constants:
  Mol. Wt. 102.13
  M. P. -73°C
  B. P. 88.4°C
  Freezing P. -69.3°C
  Flash P. 43°F (C.C.)
  Density 0.874 @20°/20°C
  Autoign. Temp. 860°F
  Vap. Press. 40 mm @17.0°C
  Vap. D. 3.52
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: Ingestion 1; Inhalation 1
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 1.78 - 7.8%
Disaster Control: Dangerous! Keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

ISOPROPYL ALCOHOL

Synonyms: Dimethyl carbinol; secondary propyl alcohol, isopropanol.
Description: Clear, colorless liquid.
Formula: $CH_3CHOHCH_3$
Constants:
  Mol. Wt. 60.09
  M. P. -88.5° to -89.5°C
  B. P. 82.3°C
  Flash P. 70°F (C.O.C.)
  Density 0.7854 @20°/4°C
  Autoign. Temp. 852°F
  Vap. Press. 33.0 mm @20°C
  Vap. D. 2.07
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1; Inhalation 1
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: Ingestion 1; Inhalation 1
MAC: ACGIH (accepted); 400 parts

per million in air; 1020 milligrams per cubic meter of air.
Toxicology: Acts as a local irritant and in high concentrations as a narcotic. It can cause corneal burns and often eye damage. It has good warning properties because it causes a mild irritation of the eyes, nose and throat at concentration levels of 400 ppm. It may induce a mild narcosis, the effects of which are usually transient, and it is somewhat less toxic than the normal isomer, but twice as volatile. It is not considered an important toxic hazard. There is some evidence that personnel can acquire a slight tolerance to this material, and single or repeated applications of it on the skin of rats, rabbits, dogs or human beings induced no untoward effects. It acts very much like ethanol in regard to absorption, metabolism and elimination but with a stronger narcotic action. Chronic injuries due to it have been detected in animals. Humans have ingested up to 20 ml diluted with water and noticed only a sensation of heat and slight lowering of the blood pressure.
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 2.5 - 5.2%
Disaster Control: Dangerous! Keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.

ISOPROPYLAMINE

Description: Colorless liquid, amine odor.
Formula: $(CH_3)_2CHNH_2$
Constants:
Mol. Wt. 59.11
M. P. −101.2°C
B. P. 31.7°C
Flash P. −15°F (O.C.)
Density 0.694 @15°/4°C
Autoign. Temp. 756°F
Vap. D. 2.03
Toxicity: Probably slight. See Amines.
MAC: ACGIH (tentative); 5 parts per million in air.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; keep away from sparks, heat or open flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

β-ISOPROPYLAMINOPROPIONITRILE

Description: Liquid.
Formula: $C_3H_7NHCH_2CH_2CN$
Constants:
Mol. Wt. 112.18
M. P. <−20°C
B. P. 86°C @17 mm
Flash P. 100°F
Density 0.864
Vap. D. 3.87
Toxicity: Highly toxic. See Cyanides.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides; will react with water or steam to produce toxic and flammable vapors; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

3-ISOPROPYLAMINOPROPYLAMINE

Description: Colorless liquid.
Formula: $(CH_3)_2CHNHCH_2CH_2CH_2NH_2$
Constants: Mol. Wt. 116.2
B. P. 159°C
Vap. D. 4.00
Density 0.827 @25°/4°C

Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of cyanides; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ISOPROPYL ANTIMONITE
Formula: $(C_3H_7O)_3Sb$
Constants:
Mol. Wt. 299.1
B. P. 82°C @7 mm
Toxicity: See Antimony Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of antimony; can react with oxidizing materials.
Storage and Handling: Section 7

ISOPROPYL BENZENE
Synonyms: Cumene; cumol.
Description: Colorless liquid.
Formula: $C_6H_5CH(CH_3)_2$
Constants:
Mol. Wt. 120.2
B. P. 152 - 153°C
Freezing P. -96.3°C
Flash P. 115°F (T.O.C.)
Density 0.862 @20°/4°C
Vap. Press. 3.62 mm @21°C
Vap. D. 4.14
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Inhalation 1
Fire Hazard: Moderate, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated it emits toxic fumes; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

ISOPROPYL BENZOATE
Description: Liquid.
Formula: $C_6H_5COOCH(CH_3)_2$
Constants:
Mol. Wt. 164.2
M. P. -26.4°C
B. P. 219°C
Flash P. 210°F (O.C.)
Density 1.0112
Vap. Press. 0.12 mm @20°C
Vap. D. 5.67
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame, can react with oxidizing materials.
To Fight Fire: Water spray, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

ISOPROPYL BROMIDE
Description: Colorless liquid.
Formula: $CH_3CHBrCH_3$
Constants:
Mol. Wt. 123.0
B. P. 58.5 - 60.5°C
Freezing P. -90°C
Density 1.304 @25°/25°C
Vap. D. 4.27
Toxicity: Details unknown. See Bromides.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes of bromides.
Storage and Handling: Section 7

ISOPROPYL CHLORIDE
Synonyms: 2-Chloropropane.
Description: Clear liquid.
Formula: $CH_3CHClCH_3$
Constants:
Mol. Wt. 78.55
B. P. 35.3°C
Freezing P. -117.6°C

Flash P. −26°F (C.C.)
Density 0.858 @25°/25°C
Autoign. Temp. 1100°F
Vap. D. 2.71
Toxicity: See Chlorinated Hydrocarbons.
Fire Hazard: Highly dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 2.8 - 10.7%
Disaster Control: Dangerous; keep away from sparks, heat or open flame; emits highly toxic fumes of chlorides such as phosgene; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ISOPROPYL m-CHLOROCARBANILATE. See Isopropyl N-(3-Chlorophenyl Carbamate).

ISOPROPYL N-(3-CHLOROPHENYL) CARBAMATE

Synonyms: Isopropyl m-chlorocarbanilate.
Description: Light brown crystalline solid, faint characteristic odor.
Formula: $C_{10}H_{12}ClNO_2$
Constants: Mol. Wt. 213.66
M. P. 36°C
Toxicity: Details unknown; an insecticide.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

ISOPROPYL 2,4-DICHLOROPHENOXYACETATE

Description: Nearly colorless crystals.
Formula: $C_6H_3Cl_2OCH_2COOCH(CH_3)_2$
Constants:
Mol. Wt. 263.13
Density 1.255 - 1.270 @25°/25°C
Toxicity: See 2,4-D.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes of chlorides.
Ventilation Control: Section 2
Storage and Handling: Section 7

ISOPROPYL ETHER

Synonyms: 2-Isopropoxypropane; diisopropyl ether.
Description: Colorless liquid, ethereal odor.
Formula: $(CH_3)_2CHOCH(CH_3)_2$
Constants: Mol. Wt. 102.17
M. P. −60°C
B. P. 68.5°C
Freezing P. −85.6°C
Flash P. −18°F (C.C.)
Density 0.719 @25°C
Autoign. Temp. 830°F
Vap. Press. 150 mm @25°C
Vap. D. 3.52
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (accepted); 500 parts per million in air; 2085 milligrams per cubic meter of air.
Fire Hazard: Highly dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Severe, when exposed to heat or flame.
Explosive Range: 1.4 - 21.0%. See also Ethers.
Disaster Control: Dangerous; keep away from heat, sparks or open flame; under some conditions shock will explode it; emits toxic fumes; reacts vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ISOPROPYL FORMATE

Synonyms: Isopropyl formate; isopropyl methanoate.
Description: Clear liquid.
Formula: $C_3H_7CHO_2$
Constants:
Mol. Wt. 88.1

B. P. 68.3°C
Flash P. 22°F (C.C.)
Density 0.873
Autoign. Temp. 905°F
Vap. Press. 100 mm @17.8°C
Vap. D. 3.03
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ISOPROPYL MANDELATE

Description: Crystals.
Formula: $C_6H_5CH(OH)COOC_3H_7$
Constant:
Mol. Wt. 194.2
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

o-ISOPROPYL PHENOL

Synonym: o-Cumenol.
Description: Colorless to amber liquid.
Formula: $(CH_3)_2CHC_6H_4OH$
Constants:
Mol. Wt. 136.2
M. P. 15.5°C
B. P. 209°C
Flash P. 220°F
Density 0.995 @25°/25°C
Vap. Press. 1 mm @56.6°C
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phenol; can react with oxidizing materials.
Storage and Handling: Section 7

p-ISOPROPYL PHENOL

Description: Needle-like crystals, white to light tan.
Formula: $(CH_3)_2CHC_6H_4OH$
Constants:
Mol. Wt. 136.2
M. P. 61°C
B. P. 228°C
Density 0.983
Vap. Press. 1 mm @67.0°C
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phenol; can react with oxidizing materials.
Storage and Handling: Section 7

4-ISOPROPYL PYRIDINE

Description: Liquid.
Formula: $(CH_3)_2CHC_5H_4N$
Constants:
Mol. Wt. 121.3
B. P. 182.2°C
Density 0.9282 @20°/20°C
Vap. D. 4.18
Toxicity: See Pyridine.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of cyanides; can react with oxidizing materials.
Storage and Handling: Section 7

ISOPROPYL TITANATE

Synonym: Titanium Isopropylate.
Description: Colorless liquid.
Formula: $Ti(OC_3H_7)_4$
Constants:
Mol. Wt. 284.2
M. P. 14.8°C
B. P. 104°C @ 10 mm
Density 0.954
Vap. D. 9.8
Toxicity: Details unknown.
Fire Hazard: Moderate, when exposed to heat or flame.
Disaster Control: It will react with water or steam to produce flammable vapors; can react with oxidizing materials.
Storage and Handling: Section 7

ISOPROPYLTRICHLOROSILANE

Description: Liquid.
Formula: $C_3H_7SiCl_3$

Constants:
- Mol. Wt. 177.5
- M. P. −87.7°C
- B. P. 119.4°C
- Density 1.196

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

ISOTHIOCYANATES. See Thiocyanates.

ISOVALERIC ALDEHYDE

Synonyms: Isovaleraldehyde; 3-methylbutanal.

Description: Colorless liquid, apple-like odor.

Formula: $(CH_3)_2CHCH_2CHO$

Constants:
- Mol. Wt. 86.13
- M. P. −51°C
- B. P. 92.5°C
- Density 0.803 @17°/4°C
- Vap. D. 2.96

Toxicity: Details unknown. See also Aldehydes.

Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).

Storage and Handling: Section 7

ITACONIC ACID

Synonym: Methylene succinic acid.

Description: White, crystalline powder.

Formula: $CH_2C(COOH)CH_2COOH$

Constants:
- Mol. Wt. 130.10
- M. P. 167.5°C (decomp.)
- Density 1.63

Toxic Hazard Rating:
- Acute Local: Irritant 1; Ingestion 1; Inhalation 1
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Slight; when heated, it emits acrid fumes.

Storage and Handling: Section 7

J

JAPAN (LACQUER)

Toxic Hazard Rating:
  Acute Local: Irritant 3; Allergen 1
  Acute Systemic: U
  Chronic Local: Irritant 3; Allergen 1
  Chronic Systemic: U

Toxicology: Dermatitis is frequently caused by natural Japan lacquer due to a highly irritating chemical urushiol (Section 9). Synthetic Japan lacquer contains linseed oil, lead oxide, pigments and solvents such as kerosene or turpentine (which see).

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

JUNIPER BERRIES

Description: Dried ripe fruit of Juniperus Communis L. Pinaceae.

Toxic Hazard Rating:
  Acute Local: Irritant 2; Allergen 1; Ingestion 2
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: Allergen 1
  Chronic Systemic: U

Toxicology: The oil of juniper berries can be irritating to the skin. If taken internally, a severe kidney irritation similar to that caused by turpentine may result.

Fire Hazard: Unknown

Disaster Control: Slightly dangerous; when heated, it emits toxic fumes.

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

JUTE

A combustible fiber. In the form of dust it may be highly flammable. See Cotton Dust.

K

KAPOK

Description: A fibrous material.
Toxic Hazard Rating:
  Acute Local: Allergen 1; Inhalation 1
  Acute Systemic: 0
  Chronic Local: Allergen 1; Inhalation 1
  Chronic Systemic: 0
Caution: Gives off a nuisance dust. Inhalation can cause coughing and sneezing.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Slight, in the form of dust when exposed to flame.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

KELP DUST

Toxicity: Details unknown. The dried material, if finely divided, may form a nuisance dust.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Ventilation Control (use normal rate): Section 2

KEROSENE

Synonym: Fuel Oil No. 1.
Description: A pale yellow to water white oily liquid.
Formula: A mixture of petroleum hydrocarbons, chiefly 6 methane series, having 10-16 C atoms.
Constants:
  B. P. 175 - 325°C
  Flash P. 100 - 165°F (C.C.)
  Density 0.80 - < 1.0
  Autoign. Temp. 490°F
  Vap. D. 4.5
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 2; Inhalation 1
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: Irritant 2
  Chronic Systemic: Inhalation 1
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Underwriters Laboratory Classification: 40
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 1.16 - 6.0%
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  Coast Guard Classification: Combustible liquid.

KERYL BENZENE-12

Synonym: Monododecyl Benzene.
Description: Very light straw color; practically odorless.
Formula: $C_{12}H_{25}C_6H_5$
Constants:
  Mol. Wt. 246.4
  Flash P. 280°F
  Density 0.894 @20°C
1 B. Range 291 - 354°C
Toxicity: Details unknown. See also Benzene.
Fire Hazard: Slight when exposed to heat or flame; can react with oxidizing materials (Section 6).
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

KERYL NAPHTHALENE 10

Synonym: Monodecyl naphthalene.
Description: Color of straw; odor of naphthalene.
Formula: $C_{10}H_7C_{10}H_{21}$
Constants: Mol. Wt. 268.4
  Flash P. 325°F
  Density 0.968 @20°C
  B. Range 341 - 420°C

Toxicity: Details unknown. See also Naphthalene.
Fire Hazard: Slight when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

KETENE

Synonym: Ethenone; carbomethane; keten.
Description: Colorless gas of disagreeable taste. Decomposes in water.
Formula: CH_2CO
Constants:
Mol. Wt. 42.04
M. P. -151°C
B. P. -56°C
Vap. D. 1.45
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3
Acute Systemic: Inhalation 3
Chronic Local: U
Chronic Systemic: Inhalation 3
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3

KETONES

Organic compounds containing the chemical group =C=O, derived from secondary alcohols by oxidation. Acetone, which is dimethyl ketone, is the most familiar of this group of compounds. See Acetone.

No general statement can be made as to the toxicity of ketones. Some are highly volatile and hence may have narcotic or anesthetic effects. Skin absorption as well as inhalation may be an important route of entry into the body. None of the ketones has been shown to have a high degree of chronic toxicity.

Some of them are dangerous fire hazards. See Diethyl ketone.

KILL-TONE POWDER. See Arsenic Oxide and Copper Compounds.

KRYOFIN

Synonym: Methoxyacetyl-p-phenetidine.
Description: White needles, tasteless but becoming bitter on chewing.
Formula: $CH_3OCH_2CONHC_6H_4OC_2H_5$
Constants:
Mol. Wt. 209.24
M. P. 98°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2
Chronic Local: U
Chronic Systemic: Ingestion 2
Fire Hazard: Slight; when heated it emits toxic fumes (Section 6).
Personal Hygiene: Section 3

KRYPTON

Description: Colorless inert gas.
Formula: Kr
Constants:
At. Wt. 83.8
M. P. -156.7°C
B. P. -152.0°C
Density 3.708 g per liter @0°C; (liq) 2.155 @-152.9°C
Toxicity: A simple asphyxiant in large concentrations. See also Argon.
Radiation Hazard (Section 5): Artificial isotope Kr^{85}, half-life about 10 years; emits beta particles of 0.74 mev and no gamma rays. Hazard Rating, Class I. Kr^{85} like A^{41} is chiefly produced by irradiation in air-cooled nuclear reactors.
Storage and Handling: Section 7

L

LACQUER BASE OR CHIPS, DRY. See Lacquers, Nitrocellulose.
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

LACQUER BASE OR CHIPS, PLASTIC (WET WITH ALCOHOL OR SOLVENT). See specific component.
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Combustible liquid; inflammable liquid; red label.

LACQUERS
Description: Solutions of resins, gums or plastics in an organic solvent.
Constant:
Flash P. 0 - 80°F
Toxicity: Variable; they may have allergic effects.
Fire Hazard: Dangerous, when exposed to heat or flame. A large part of the great fire hazard of lacquers is due to the solvents commonly used. Even when solvent-free, however, nitrocellulose lacquers are highly flammable. See Lacquers, Nitrocellulose.
To Fight Fire: Carbon dioxide, dry chemical, carbon tetrachloride, or water spray (Section 6).
Explosion Hazard: Severe, in the form of vapor when exposed to flame (Section 7). See also individual solvents as well as individual solid component.
Disaster Control: Dangerous; keep away from heat and open flame! They can react vigorously with oxidizing materials.
Explosive Range: Variable.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Combustible material.

LACQUERS, NITROCELLULOSE
Constant:
Flash P. 40°F
Toxicity: Variable, they may have allergic effects.
Fire Hazard: Highly dangerous, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Disaster Control: Dangerous. On decomposition they may emit highly toxic fumes.
Ventilation Control: (use moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Combustible liquid; inflammable liquid; red label.

LACTIC ACID
Synonym: Ethylidenelactic acid.
Description: Yellow or colorless, thick liquid.
Formula:
$CH_3CHOHCOOH$
Constants:
Mol. Wt. 90.08
M. P. 18°C
B. P. 122° @15 mm
Density 1.249 @15°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U

Fire Hazard: Slight; emits acrid fumes when heated.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

LACTOL SPIRITS. See Naphtha, Petroleum.

LACTONITRILE

Synonym: 2-Hydroxypropanenitrile.
Description: Straw-colored liquid.
Formula: $CH_3CH(OH)CH$
Constants: Mol. Wt. 71.08
M. P. -40°C
B. P. 103°C @50 mm
Freezing P. -34°C
Flash P. 170°F (T.C.C.)
Density 0.9834 @25°C
Vap. D. 2.45
Toxicity: Highly toxic. See Cyanides.
Caution: In the presence of alkali, it evolves hydrocyanic acid.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride.
Explosion Hazard: See Cyanides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

LAMP BLACK. See Carbon.

LANOLIN

Synonym: Wool grease.
Constants:
M. P. 37.9°C
Flash P. 460°F (C.C.)
Density Less than 1
Autoign. Temp. 833°F
Toxicity: A mild allergen.
Fire Hazard: Slight when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: Yes
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

LANTHANUM

Description: Lead-gray metal.
Constants:
At. Wt. 138.92
M. P. 826°C
B. P. 1800°C
Density 6.15
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Inhalation 1
Chronic Local: U
Chronic Systemic: U
Radiation Hazard (Section 5): Artificial isotope La^{140}, half-life: 40h; emits beta particles of 1.3 mev (70%), 1.7 mev (20%) and 2.3 mev (10%) and many gamma rays between 0.093 - 2.5 mev. The permissible levels are: in body: 5 microcuries; in air: 6×10^{-8} microcurie per milliliter; in water: 2×10^{-3} microcurie per milliliter.

La^{140} usually exists in equilibrium with its parent, Ba^{140}. The hazard rating and permissible levels apply to the equilibrium mixture. For La^{140} alone, the hazard rating is still II, but the permissible levels are: body = 24 microcuries; air = 10^{-6} microcurie per milliliter and water = a microcurie per milliliter. Hazard Rating, Class II (National Bureau of Standards Handbook No. 42).

Fire Hazard: Dangerous in the form of dust when exposed to flame; can react vigorously with oxidizing materials. See also Powdered Metals.
Explosion Hazard: Moderate in the form of dust when exposed to flame or by chemical reaction. See also Powdered Metals.
Storage and Handling: Section 7

LANTHANUM BORIDE

Synonym: Lanthanum hexaboride.
Description: Red-purple, metallic crystals.
Formula: LaB_6
Constants:
Mol. Wt. 203.8
M. P. 2210°C
B. P. Decomposes
Density 2.61

Toxicity: Details unknown. See Boron Hydrides.
Fire Hazard: Moderate, because on contact with moisture or acids boron hydride is evolved. See also Boron Hydride.
Explosion Hazard: See Boron Hydrides.
Disaster Control: See Boron Hydrides.
Storage and Handling: Section 7

LANTHANUM BROMATE

Description: Crystals.
Formula: $La(BrO_3)_3 \cdot 9H_2O$
Constants:
  Mol. Wt. 684.81
  M. P. 37.5°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: 0
  Chronic Systemic: U
Fire Hazard: See Bromates.
Explosion Hazard: See Bromates.
Disaster Control: See Bromates.
Storage and Handling: Section 7

LANTHANUM BROMIDE

Description: Colorless crystals.
Formula: $LaBr_3 \cdot 7H_2O$
Constants:
  Mol. Wt. 504.78
  M. P. Anh. 783 ± 3
  Density 5.057 @25°C
Toxicity: See Bromides.
Disaster Control: See Bromides.
Storage and Handling: Section 7

LANTHANUM CARBIDE

Description: Yellow crystals.
Formula: LaC_2
Constants:
  Mol. Wt. 162.94
  Density 5.02
Toxicity: See Lanthanum and Carbides.
Fire Hazard: See Carbides.
Explosion Hazard: See Carbides.
Disaster Control: See Carbides.

LANTHANUM HEXAANTIPYRINE PERCHLORATE

Description: Colorless, hexagonal crystals.
Formula: $[La(C_{11}H_{12}N_2O)_6] \cdot (ClO_4)_3$
Constants: Mol. Wt. 1566.62
  M. P. 290-305°C Decomposes
Toxicity: Moderate. See Perchlorates.
Fire Hazard: Dangerous. See Perchlorates.
Explosion Hazard: Moderate. See Perchlorates.
Disaster Control: Dangerous. See Perchlorates.
Storage and Handling: Section 7

LANTHANUM IODATE

Description: Colorless.
Formula: $La(IO_3)_3$
Constant:
  Mol. Wt. 663.68
Toxicity: See Iodates.
Fire Hazard: See Iodates.
Explosion Hazard: See Iodates.
Disaster Control: See Iodates.
Storage and Handling: Section 7

LANTHANUM IODIDE

Description: Crystals.
Formula: LaI_3
Constants:
  Mol. Wt. 519.68
  M. P. 761 ± 2°C
  Density 5.057 @25°C
Toxicity: See Iodides.
Disaster Control: See Iodides.
Storage and Handling: Section 7

LANTHANUM OXIDE

Synonyms: Lanthana; lanthanum trioxide.
Description: White, amorphous oxide; hisses in moist air like quicklime.
Formula: La_2O_3
Constants:
  Mol. Wt. 325.84
  M. P. 2315°C
  B. P. 4200°C
  Density 6.51
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Inhalation 1
  Chronic Local: U
  Chronic Systemic: U
Ventilation Control (use normal rate): Section 2

LANTHANUM SULFATE

Description: White, hygroscopic powder.
Formula: $La_2(SO_4)_3$
Constants: Mol. Wt. 566
  M. P. 1150°C (Decomposes)
  Density 3.60 @15°C

Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Caution: Lanthanum and sulfuric acid are formed upon hydrolysis of this material.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3

LANTHANUM SULFIDE
Description: Red-yellow crystals.
Formula: La_2S_3
Constants:
  Mol. Wt. 374.04
  M. P. 2110-2150°C (vac.)
  Density 5.0 @0°/0°C
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

LARD OIL (COMMERCIAL OR ANIMAL)
Description: Colorless or pale yellow liquid.
Composition: Olein, stearin.
Constants:
  M. P. −2°C
  Flash P. 395°F (C.C.)
  Density 0.905 - 0.915
  Autoign. Temp. 883°F
Toxicity: A very weak allergen.
Fire Hazard: Slight when exposed to heat or flame; can react with oxidizing materials.
Underwriters Laboratory Classification: 10-20.
Spontaneous Heating: Yes
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

LARD OIL (PURE)
Synonym: No. 2 mineral oil.
Description: Colorless or pale yellow liquid.
Constants:
  M. P. 28°F
  Flash P. 500°F
  Density 0.9
Toxicity: Unknown
Fire Hazard: Slight when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: Yes
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

LATEX, RUBBER
Toxic Hazard Rating:
  Acute Local: Irritant 2; Allergen 1; Ingestion 2
  Acute Systemic: U
  Chronic Local: Allergen 2
  Chronic Systemic: U
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: This material is shipped in sealed drums which can build up pressure from within, unless care is used in opening this can endanger personnel. Latex contains ammonia as a preservative, and caution should be exercised in opening the drums not to inhale the fumes evolved (Section 7).

LAUDANINE
Synonym: dl-laundanine.
Description: Small trimetric yellowish-white powder.
Formula: $C_{20}H_{25}NO_4$
Constants:
  Mol. Wt. 343.41
  M. P. 166°C
  Density 1.26 @26°/4°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

LAUDANOSINE
Synonym: 1-N-Methyltetrahydropapaverine.

Description: White needles.
Formula: $C_{21}H_{27}NO_4$
Constants:
  Mol. Wt. 357.44
  M. P. 89 - 90°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

LAUDANUM

Description: Brown liquid.
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: Ingestion 2; Inhalation 2
Fire Hazard: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

LAURIC ACID

Synonym: Dodecanoic acid.
Description: Colorless, needle-like crystals.
Formula: $CH_3(CH_2)_{10}COOH$
Constants:
  Mol. Wt. 200.3
  M. P. 48°C
  B. P. 299.2°C
  Density 0.883
  Vap. Press. 1 mm @121.0°C
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

LAUROYL PEROXIDE

Synonym: Dodecanoyl peroxide.
Description: White, tasteless, coarse powder; faint odor.
Formula: $(C_{11}H_{23}CO)_2O_2$
Constants:
  Mol. Wt. 398.60
  M. P. 48 - 50°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Toxicology: It can irritate and cause burns upon the skin and mucous membranes; it is a powerful oxidizing agent. See also Peroxides, Organic.
Fire Hazard: See Peroxides, Organic.
Disaster Control: See Peroxides, Organic.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Oxidizing material; yellow label.
  Coast Guard Classification: Oxidizing material; yellow label.

LAURYL BROMIDE

Synonym: Dodecyl bromide.
Description: An amber liquid.
Formula: $CH_3(CH_2)_{10}CH_2Br$
Constants:
  Mol. Wt. 249.2
  M. P. < -40°C
  B. P. 136.6-193.5°C @10 mm
  Flash P. 291°F
  Density 1.021 @25°/25°C
  Vap. D. 8.6
Toxicity: Details unknown. See also Bromides.
Fire Hazard: Slight when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of bromine compounds; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

LAURYL CHLORIDE

Synonym: Dodecyl chloride.

Description: Clear, water-white, oily liquid.
Formula: $CH_3(CH_2)_{10}CH_2Cl$
Constants: Mol. Wt. 204.8
M. P. −19°C
B. P. 112 - 160°C
Flash P. 235°F
Density 0.87
Vap. D. 7.07
Toxicity: Unknown
Fire Hazard: Slight when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes; it can react with oxidizing materials.
Storage and Handling: Section 7

LAURYL ISOQUINOLINIUM BROMIDE

Toxicity: Details unknown. See also Bromides.
Fire Hazard: Slight when exposed to heat or flame (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

LAURYL MERCAPTAN

Synonym: Dodecyl mercaptan.
Description: Water-white to pale yellow liquid.
Formula: $C_{12}H_{25}SH$
Constants:
Mol. Wt. 202.5
M. P. −7°C
B. P. 115 - 177°C
Flash P. 262°F
Density 0.849 @15.5°/15.5°C
Toxicity: See Mercaptans.
Fire Hazard: Slight when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: See Mercaptans.
Storage and Handling: Section 7

LAURYL PYRIDINIUM CHLORIDE

Synonym: Dodecyl pyridinium chloride.
Description: Mottled tan semi-solid.
Formula: $C_5H_5NC_{12.6}H_{26.2}Cl$
Constants: Mol. Wt. 292.0
Flash P. 347°F
Toxicity: Unknown
Fire Hazard: Slight when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

LAURYL QUINALDINIUM BROMIDE

Toxicity: Details unknown. See also Bromides.
Fire Hazard: Unknown.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

LAURYL QUINOLINIUM CHLORIDE

Toxicity: Details unknown; a fungicide.
Fire Hazard: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes.
Storage and Handling: Section 7

LAURYL THIOCYANATE

Formula: $CH_3(CH_2)_{10}CH_2SCN$
Constant:
Mol. Wt. 227.3
Toxicity: See Thiocyanates.
Fire Hazard: Unknown
Explosion Hazard: Unknown
Disaster Control: See Thiocyanates.
Storage and Handling: Section 7

LEAD

Synonym: Plumbum.
Description: Bluish-gray, soft metal.
Formula: Pb
Constants:
At. Wt. 207.21
M. P. 327.43°C
B. P. 1620°C
Density 11.288 @20°/20°C
Vap. Press. 1 mm @973°C
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Inhalation 3
Chronic Local: 0
Chronic Systemic: Ingestion 3; Inhalation 3
MAC: ACGIH (accepted); 0.15 milligrams per cubic meter of air.
Radiation Hazard (Section 5):
Natural isotope Pb^{210} (Radium D),

half-life 22 years; emits beta particles of 0.028 mev and gamma rays of 0.008, 0.046 mev.

Pb^{210} is a member of the uranium series. It is the longest-lived daughter of radium, and hence does not accumulate rapidly in radium preparations. Like other lead isotopes, it is a bone seeker and its daughters, Bi^{210} and Po^{210}, may cause excessive irradiation of the blood-forming organs, even though the Pb^{210} itself has an exceedingly low-energy beta emission.

Natural isotope Pb^{212} (Thorium B), half-life 10.6 hours; emits beta particles of 0.34 mev (88% and 0.58 mev (12%) and gamma rays of 0.24 mev.

Like Pb^{210}, Pb^{212} is a member of the thorium series and a daughter of thoron.

Fire Hazard: Moderate, in the form of dust when exposed to heat or flame. See also Powdered Metals.
Explosion Hazard: Moderate, in the form of dust when exposed to heat or flame.
Disaster Control: Dangerous; when heated it emits highly toxic fumes; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

LEAD ACETATE

Synonym: Sugar of lead.
Description: White crystals, soluble in water. Commercial grades are frequently brown or gray lumps.
Formula: $Pb(C_2H_3O_2)_2 \cdot 3H_2O$
Constants:
Mol. Wt. 379.35
M. P. 75°C; anhydrous 280°C
Density 2.55
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD ACETATE, MONOBASIC

Description: White powder.
Formula:
$PB_2OH(C_2H_3O_2)_3$
Constant:
Mol. Wt. 608.6
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD ANTIMONATE

Synonyms: Naples yellow; antimony yellow.
Description: Orange-yellow powder.
Formula: $Pb_3(SbO_4)_2$
Constant:
Mol. Wt. 993.2
Toxicity: See Lead and Antimony Compounds.
Disaster Control: See Lead and Antimony.
Storage and Handling: Section 7

LEAD ARSENATES

Synonyms: Lead o-arsenate; lead di-o-arsenate; lead mono-o-arsenate; lead pyroarsenate; lead meta-arsenate.
Description: White crystals.
Toxicity: Highly toxic.
MAC: ACGIH (tentative); 0.2 milligrams per cubic meter of air.
Disaster Control: Dangerous; on heating it emits highly toxic fumes.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

LEAD ARSENITES

Synonyms: Lead o-arsenite; lead m-arsenite.
Description: White powder.
Toxicity: Highly toxic.
Disaster Control: Dangerous; on heating it emits highly toxic fumes.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

LEAD m-ARSENITE. See Lead Arsenites.

LEAD AZIDE

Description: Colorless needles.

Formula: $Pb(N_3)_2$
Constant:
Mol. Wt. 291.26
Toxicity: See Lead Compounds and Azides.
Fire Hazard: Unknown
Explosion Hazard: Severe, when shocked or exposed to heat or flame. Explodes @350°C (Section 7).
Disaster Control: Highly dangerous; shock and heat will explode it; when heated it emits highly toxic fumes of lead.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Explosive A

LEAD BENZOATE
Description: White crystals.
Formula: $Pb(C_7H_5O_2)_2 \cdot H_2O$
Constants:
Mol. Wt. 467.5
M. P. $-H_2O$ @100°C
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD m-BORATE
Description: White powder.
Formula: $Pb(BO_2)_2 . H_2O$
Constants:
Mol. Wt. 310.87
Density 5.598 (anhydrous)
Toxicity: See Lead and Boron Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD BROMATE
Description: Monoclinic crystals.
Formula: $Pb(BrO_3)_2 . H_2O$
Constants:
Mol. Wt. 481.06
M. P. Decomposes 180°C
Density 5.53
Toxicity: See Lead Compounds.
Fire Hazard: See Bromates.
Explosion Hazard: See Bromates.
Disaster Control: See Bromates and Lead.
Storage and Handling: Section 7

LEAD CAPRATE
Formula: $Pb(C_{10}H_{19}O_2)_2$
Constants: Mol. Wt. 549.71
M. P. 103 - 104°C
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD CAPROATE
Description: Crystals.
Formula: $Pb(C_6H_{11}O_2)_2$
Constants:
Mol. Wt. 437.51
M. P. 73 - 74°C
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD CAPRYLATE
Description: White leaf.
Formula: $Pb(C_8H_{15}O_2)_2$
Constants:
Mol. Wt. 493.61
M. P. 83.5 - 84.5°C
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD CARBONATE
Synonym: Cerussite.
Description: White, powdery crystals.
Formula: $PbCO_3$
Constants:
Mol. Wt. 267.22
M. P. Decomposes @315°C
Density 6.6
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD CARBONATE, BASIC
Synonyms: White lead; hydrocirussite.
Description: White, amorphous powder.
Formula: $2PbCO_3 \cdot Pb(OH)_2$
Constants: Mol. Wt. 775.67
M. P. Decomposes @400°C
Density 6.14
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD CEROTATE
Description: White crystals.
Formula: $Pb(C_{26}H_{51}O_2)_2$
Constants: Mol. Wt. 998.55
M. P. 113.5°C
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD CHLORATE

Description: Monoclinic, white crystals.
Formula: $Pb(ClO_3)_2$
Constants:
  Mol. Wt. 374.12
  M. P. Decomposes
  Density 3.89
Toxicity: See Lead Compounds.
Fire Hazard: See Chlorates.
Explosion Hazard: See Chlorates.
Disaster Control: See Lead and Chlorates.
Storage and Handling: Section 7

LEAD CHLORIDE

Synonym: Cotunnite.
Description: White crystals.
Formula: $PbCl_2$
Constants:
  Mol. Wt. 278.12
  M. P. 501°C
  B. P. 954°C
  Density 5.85
  Vap. Press. 1 mm @ 547°C
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD CHLORITE

Description: Monoclinic, yellow crystals.
Formula: $Pb(ClO_2)_2$
Constants:
  Mol. Wt. 342.12
  M. P. Explodes @ 126°C
Toxicity: See Lead Compounds.
Fire Hazard: See Chlorites.
Explosion Hazard: Severe, when exposed to heat.
Explosive Range: @ 126°C
Disaster Control: See Chlorites and Lead.
Storage and Handling: Section 7

LEAD CHROMATE

Synonyms: Crocoite; chrome yellow.
Description: Yellow crystals.
Formula: $PbCrO_4$
Constants:
  Mol. Wt. 323.22
  M. P. 844°C
  B. P. Decomposes
  Density 6.3
Toxicity: See Lead and Chromium Compounds.
Fire Hazard: Moderate by chemical reaction with reducing agents.
Disaster Control: Dangerous when heated to decomposition, it emits highly toxic fumes of lead and can react vigorously with reducing material.
Storage and Handling: Section 7

LEAD CHROMATE, BASIC

Description: Red, amorphous or crystals.
Formula: $Pb_2(OH)_2CrO_4$
Constants:
  Mol. Wt. 564.45
  M. P. 920°C
Toxicity: See Lead and Chromium Compounds.
Fire Hazard: Moderate, by chemical reaction with reducing agents.
Disaster Control: Dangerous, when heated to decomposition, it emits highly toxic fumes of lead and can react vigorously with reducing material.
Storage and Handling: Section 7

LEAD CITRATE

Description: White, crystalline powder.
Formula: $Pb_3(C_6H_5O_7)_2 \cdot 3H_2O$
Constant:
  Mol. Wt. 1053.88
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD COMPOUNDS

Toxic Hazard Rating:
  Acute Local: 0
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: 0
  Chronic Systemic: Ingestion 3; Inhalation 3; Absorption 3

Toxicology: Lead poisoning is one of the commonest of occupational diseases. The presence of lead-bearing materials or lead compounds in an industrial plant does not necessarily result in exposure on the part of the workman. The lead must be in such form, and so distributed, as to gain entrance into the body or tissues of the workman in measurable quantity, otherwise no exposure can be said to exist.

Mode of entry into body:

1. By inhalation of the dusts, fumes, mists or vapors.

2. By ingestion of lead compounds trapped in the upper respiratory tract or introduced into the mouth on food, tobacco, fingers or other objects.
3. Through the skin; this route is of especial importance in the case of the organic compounds of lead, as lead tetraethyl. In the case of the inorganic forms of lead, this route is of no practical importance.

Physiological Action and Toxicity: When lead is ingested, much of it passes through the body unabsorbed, and is eliminated in the feces. The greater portion of the lead that is absorbed is caught by the liver and excreted, in part, in the bile. For this reason, larger amounts of lead are necessary to cause poisoning if absorption is by this route, and a longer period of exposure is usually necessary to produce symptoms. On the other hand, when lead is inhaled, absorption takes place easily from the respiratory tract and symptoms tend to develop more quickly. From the point of view of industrial poisoning, inhalation of lead is much more important than is ingestion.

Lead is a cumulative poison increasing amounts build up in the body and eventually a point is reached where symptoms and disability occur.

Lead produces a brittleness of the red blood cells so that they hemolyze with but slight trauma; the hemoglobin is not affected. Due to their increased fragility, the red cells are destroyed more rapidly in the body than normally, producing an anemia which is rarely severe. The loss of circulating red cells stimulates the production of new young cells which on entering the blood stream, are acted upon by the circulating lead, with resultant coagulation of their basophilic material. These cells after suitable staining, are recognizedas "stippled cells". As regards the effect of lead on the white blood cells, there is no uniformity of opinion. In addition to its effect on the red cells of the blood, lead produces a damaging effect on the organs or tissues with which it comes in contact. No specific or characteristic lesion is produced. Autopsies of deaths attributed to lead poisoning and experimental work on animals, have shown pathological lesion of the kidneys, liver, male gonads, nervous system, blood vessels and other tissues. None of these changes, however, have been found consistently.

In cases of lead poisoning, the amount of lead found in the blood is frequently in excess of 0.07 mgm per 100 cc of whole blood. The urinary lead excretion generally exceeds 0.1 mgm per liter of urine.

The toxicity of the various lead compounds appears to depend upon several factors: (1) the solubility of the compound in the body fluids; (2) the fineness of the particles of the compound; solubility is greater, of course, in proportion to the fineness of the particles; (3) conditions under which the compound is being used; where a lead compound is used as a powder, contamination of the atmosphere will be much less where the powder is kept damp. Of the various lead compounds, the carbonate, the monoxide and the sulfate are considered to be more toxic than metallic lead or other lead compounds. Lead arsenate is very toxic, due to the presence of the arsenic radicle. The toxicity of lead chromate, or "chrome yellow" is less than would be expected, due to its low solubility.

Signs and Symptoms: Industrial lead poisoning commonly occurs following prolonged exposure to lead or its compounds. The common clinical types of lead poisoning may be classified according to their clinical picture as (a) alimentary; (b) neuromotor; and (c) encephalic. Some cases may show a combination of clinical types. The alimentary type occurs most frequently, and is characterized by abdominal discomfort or pain. Severe cases may present actual colic. Other complaints are constipation and/or diarrhea, loss of appetite, metallic taste, nausea and vomiting, lassitude, insomnia, weakness, joint and muscle pains, irritability, headache and dizziness. Pallor, lead line on the gums, pyorrhea, loss of weight, abdominal tenderness, basophilic stippling, anemia, slight albuminuria, increased urinary excretion, and an increase in the lead content of the whole blood, are signs which may accompany the above symptoms.

In the neuromuscular type, the chief complaint is weakness, frequently of the extensor muscles of the wrist and hand, unilateral or bilateral. Other muscle groups which are subject to constant use may be affected. Gastroenteric symptoms are usually present, but are not as severe as in the alimentary type of poisoning. Joint and muscle pains are likely to be more severe. Headache, dizziness and insomnia are frequently prominent. True paralysis is uncommon, and usually is the result of prolonged exposure.

Lead encephalopathy is the most severe but the rarest manifestation of lead poisoning. In the industrial worker it follows rapid and heavy lead absorption. Organic lead compounds, such as tetraethyl lead, are absorbed rapidly through the skin as well as through the lungs, and are selectively absorbed by the central nervous system. The clinical picture in these cases is usually an encephalopathy. With inorganic lead compounds, comparable concentrations in the central nervous system are reached only when the workplace is heavily contaminated with vapor, fume and dust. Encephalopathy begins abruptly, and is characterized by signs of cerebral and meningeal involvement. There is usually stupor, progressing to coma, with or without convulsion, and often terminating in death. Excitation, confusion and mania are less common. In milder cases of shorter duration, there may be symptoms of headache, dizziness, somnolence and insomnia. The cerebrospinal pressure may be increased. See also specific compound.

Treatment of Lead Poisoning: It has been found that the chelating agent, calcium ethylenediaminetetracetate, and related compounds are highly efficacious in removing absorbed lead from the tissues of the body. (The therapeutic agents of this group are also known as Versene, Versenate, Edathamil and Ca EDTA.)

Ca EDTA is effective only when administered intravenously. Various dosage schedules have been proposed. An effective regime is 3 to 6 grams of Na Ca EDTA in 300 cc to 500 cc of 5 percent glucose by intravenous drip over a period of 3 to 8 hours. Treatment may be given daily for 5 to 10 days with an interval of one week between courses. Another plan is to give treatment at intervals of 3 to 5 days until deleading has been accomplished.

Disaster Control: See Lead.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1

LEAD CYANATE

Description: White needles.
Formula: $Pb(OCN)_2$
Constants:
  Mol. Wt. 291.25
  M. P. Decomposes
Toxicity: See Lead Compounds and Cyanates.
Disaster Control: See Cyanates and Lead.
Storage and Handling: Section 7

LEAD CYANIDE

Description: White powder.
Formula: $Pb(CN)_2$
Constant:
  Mol. Wt. 259.25
Toxicity: See Lead Compounds and Cyanides.
Fire Hazard: See Cyanides.
Explosion Hazard: See Cyanides.
Disaster Control: See Cyanides and Lead.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: See Section 73.370.
  Coast Guard Classification: Poison B; poison label.

LEAD DICHROMATE

Description: Red crystals.
Formula: $PbCr_2O_7$
Constant:
  Mol. Wt. 423.23
Toxicity: See Lead and Chromium Compounds.
Fire Hazard: Moderate by chemical reaction with reducing agents (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits

highly toxic fumes of lead and can react vigorously with reducing materials.
Storage and Handling: Section 7

LEAD DICYANOGUANIDINE
Description: Crystals.
Formula: $Pb[NH_2CN(NCN)CN]_2$
Constants:
Mol. Wt. 423.4
M. P. >300°C
Toxicity: This material may be quite toxic by skin absorption. See also Lead Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, emits highly toxic fumes of lead and cyanides.
Storage and Handling: Section 7

LEAD DIIODIDE
Description: Golden-yellow crystals or powder.
Formula: PbI_2
Constants:
Mol. Wt. 461.05
M. P. 402°C
B. P. 954°C
Density 6.16
Toxicity: See Lead Compounds and Iodides.
Disaster Control: See Lead and Iodides.
Storage and Handling: Section 7

LEAD DIMETHYLDITHIOCARBAMATE
Description: Gray solid.
Formula: $PbS_2[(CH_3)_2CS]_2$
Constants: Mol. Wt. 447.6
M. P. 258°C
Density 2.5
Toxicity: See Lead Compounds.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of lead and oxides of sulfur.
Storage and Handling: Section 7

LEAD DIOXIDE
Synonyms: Plattnerite; lead peroxide.
Description: Brown, hexagonal crystals.
Formula: PbO_2
Constants: Mol. Wt. 239.21
M. P. Decomposes @290°C
Density 9.375
Toxicity: See Lead Compounds.
Fire Hazard: Slight chemical reaction with reducing agents. May ignite organic materials when mixed (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of lead; can react with reducing material.
Storage and Handling: Section 7

LEAD DI-o-PHOSPHATE
Description: Colorless crystals.
Formula: $PbHPO_4$
Constanst: Mol. Wt. 303.20
M. P. Decomposes
Density 5.661 @15°C
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD DITHIONATE
Description : Crystals.
Formula: $PbS_2O_6 \cdot 4H_2O$
Constants: Mol. Wt. 439.39
M. P. Decomposes
Density 3.22
Toxicity: See Lead Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of lead and oxides of sulfur.
Storage and Handling: Section 7

LEAD DUST. See Lead.

LEAD ENANTHATE
Description: White leaf-like crystals.
Formula: $Pb(C_7H_{13}O_2)_2$
Constants:
Mol. Wt. 465.56
M. P. 79° -80°C
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD FERRICYANIDE
Description: Black-brown to red crystals.
Formula: $Pb_3[Fe(CN)_6]_2$
Constant: Mol. Wt. 1135.65
Toxicity: See Lead Compounds.
Disaster Control: See Lead and Ferricyanides
Storage and Handling: Section 7

LEAD FERRITE
Description: Hexagonal crystals.
Formula: $PbFe_2O_4$
Constants:
  Mol. Wt. 382.89
  M. P. 1530°C (decomp.)
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD FERROCYANIDE
Description: Yellowish-white powder.
Formula: $Pb_2Fe(CN)_6 \cdot 3H_2O$
Constants:
  Mol. Wt. 680.43
  M. P. $-H_2O$ @100°C
Toxicity: See Lead Compounds.
Disaster Control: See Lead and Ferrocyanides.
Storage and Handling: Section 7

LEAD FLUORIDE
Description: Colorless solid.
Formula: PbF_2
Constants:
  Mol. Wt. 245.2
  M. P. 855°C
  B. P. 1293°C
  Density 8.24
  Vap. Press. 10 mm @904°C
Toxicity: See Lead Compounds and Fluorides.
Disaster Control: See Lead and Fluorides.
Storage and Handling: Section 7

LEAD FLUOSILICATE
Description: Monoclinic, colorless powder.
Formula: $PbSiF_6 \cdot 2H_2O$
Constants:
  Mol. Wt. 385.30
  M. P. Decomposes
Toxicity: See Lead Compounds and Fluosilicates.
Disaster Control: See Lead and Fluosilicates.
Storage and Handling: Section 7

LEAD FORMATE
Description: Rhombic, white, lustrous.
Formula: $Pb(CHO_2)_2$
Constants:
  Mol. Wt. 297.25
  M. P. Decomposes @190°C
  Density 4.63
Toxicity: See Lead Compounds.
Disaster Control: See Lead
Storage and Handling: Section 7

LEAD HYDROXIDE
Synonyms: Lead hydrate; hydrated lead oxide.
Description: White, bulky powder.
Formula: $Pb(OH)_2$
Constants:
  Mol. Wt. 241.23
  M. P. Decomposes @145°C
  Density 7.592
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD IODATE
Description: White solid.
Formula: $Pb(IO_3)_2$
Constants:
  Mol. Wt. 557.05
  M. P. Decomposes @300°C
Toxicity: See Lead Compounds.
Fire Hazard: See Iodates.
Explosion Hazard: See Iodates.
Disaster Control: See Iodates and Lead.
Storage and Handling: Section 7

LEAD ISOBUTYRATE
Description: White prisms.
Formula: $Pb(C_4H_7O_2)_2$
Constants:
  Mol. Wt. 381.40
  M. P. < 100°C
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD LAURATE
Description: Chalky white powder.
Formula: $Pb(C_{12}H_{23}O_2)_2$
Constants:
  Mol. Wt. 605.82
  M. P. 104.7°C
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD LIGNOCERATE
Description: White powder.
Formula: $Pb(C_{24}H_{47}O_2)_2$
Constants:
  Mol. Wt. 942.44
  M. P. 117°C
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD LINOLEATE
Description: Yellowish-white paste.
Formula: $Pb(C_{18}H_{31}O_2)_2$
Constant:
Mol. Wt. 766.07
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD MELISSATE
Description: White powder.
Formula: $Pb(C_{31}H_{61}O_2)_2$
Constants:
Mol. Wt. 1138.81
M. P. 115 - 116°C
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD MERCAPTIDE
Toxicity: See Lead Compounds and Mercaptans.
Disaster Control: See Lead and Mercaptans.
Storage and Handling: Section 7

LEAD MOLYBDATE
Synonym: Wulfenite.
Description: Yellow powder.
Formula: $PbMoO_4$
Constants: Mol. Wt. 367.16
M. P. 1070°C
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD MONOIODIDE
Description: Pale yellow
Formula: PbI
Constants:
Mol. Wt. 334.13
M. P. Decomposes @300°C
Toxicity: See Lead Compounds.
Disaster Control: See Lead and Iodides.
Storage and Handling: Section 7

LEAD MONO-o-PHOSPHATE
Description: Needles.
Formula: $Pb(H_2PO_4)_2$
Constant:
Mol. Wt. 401.28
Toxicity: See Lead Compounds.
Disaster Control: See Lead and Phosphates.
Storage and Handling: Section 7

LEAD MYRISTATE
Description: White powder.
Formula: $Pb(C_{14}H_{27}O_2)_2$
Constants:
Mol. Wt. 661.92
M. P. 107°C
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD β-NAPHTHALENESULFONATE
Description: White, crystalline powder.
Formula: $Pb(C_{10}H_7SO_3)_2$
Constant:
Mol. Wt. 621.64
Toxicity: See Lead Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of lead and oxides of sulfur.
Storage and Handling: Section 7

LEAD NITRATE
Description: White crystals.
Formula: $Pb(NO_3)_2$
Constants:
Mol. Wt. 331.23
M. P. Decomposes @470°C
Density 4.53 @20°C
Toxicity: See Lead Compounds.
Fire Hazard: See Nitrates.
Disaster Control: See Lead and Nitrates.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material.

LEAD OLEATE
Description: White, ointment-like granules or mass.
Formula: $Pb(C_{18}H_{33}O_2)_2$
Constant:
Mol. Wt. 770.10
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD OXALATE
Description: Heavy, white powder.
Formula: PbC_2O_4
Constants:
Mol. Wt. 295.23
M. P. Decomposes @300°C
Density 5.28
Toxicity: See Lead Compounds and Oxalates.

Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD OXIDE

Synonym: Red lead, minium.
Description: Bright red powder.
Formula: Pb_3O_4
Constants:
- Mol. Wt. 685.6
- M. P. 890°C (decomp.)
- B. P. 1472°C
- Density 8.32 - 9.16
- Vap. Press. 1 mm @943°C

Toxicity: See Lead Compounds.
Fire Hazard: Slight by chemical reaction with reducing agents (Section 6).
Caution: An oxidizing agent.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD OXYCHLORIDES

Synonyms: Mendipite; cassel yellow laurionite; matlockite.
Description: Yellow or white solid.
Composition: $PbCl_2$ + varying amounts of PbO and possibly some H_2O.
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD PALMITATE

Description: Chalky white powder.
Formula: $Pb(C_{16}H_{31}O_2)_2$
Constants:
- Mol. Wt. 718.03
- M. P. 112.3°C

Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD PARAPERIODATE

Description: Crystals.
Formula: $PbHIO_5$
Constants:
- Mol. Wt. 415.14
- M. P. Decomposes @130°C

Toxicity: See Lead Compounds and Iodates.
Fire Hazard: See Periodates.
Explosion Hazard: See Periodates.
Disaster Control: See Lead and Periodates.
Storage and Handling: Section 7

LEAD PERCHLORATE

Description: Crystals.
Formula: $Pb(ClO_4)_2 \cdot 3H_2O$
Constants:
- Mol. Wt. 460.17
- M. P. Decomposes @100°C
- Density 2.6

Toxicity: See Lead Compounds.
Fire Hazard: See Perchlorates.
Explosion Hazard: See Perchlorates.
Disaster Control: See Lead and Perchlorates.
Storage and Handling: Section 7

LEAD PHENATE

Description: Yellowish to grayish-white powder.
Formula: $Pb(OH)OC_6H_5$
Constant:
- Mol. Wt. 317.28

Toxicity: See Lead Compounds and Phenol.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD m-PHOSPHATE

Description: Colorless crystals.
Formula: $Pb(PO_3)_2$
Constants:
- Mol. Wt. 365.17
- M. P. 800°C

Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD o-PHOSPHATE

Description: Hexagonal, colorless or white powder.
Formula: $Pb_3(PO_4)_2$
Constants:
- Mol. Wt. 811.59
- M. P. 1014°C
- Density 6.9 - 7.3

Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD o-PHOSPHITE

Description: White powder.
Formula: $PbHPO_3$
Constants:
- Mol. Wt. 287.20
- M. P. Decomposes

Toxicity: See Lead Compounds and Phosphites.
Disaster Control: See Lead and Phosphites.
Storage and Handling: Section 7

LEAD PICRATE
Description: Yellow crystals.
Formula: $Pb(C_6H_2N_3O_7)_2 \cdot H_2O$
Constants:
  Mol. Wt. 681.43
  M. P. $-H_2O$ @130°C
  B. P. Explodes
  Density 2.831 @20°C
Toxicity: See Lead Compounds and Picrates.
Fire Hazard: See Nitrates and Explosives, High.
Explosion Hazard: See Explosives, High.
Disaster Control: See Lead and Nitrates.
Storage and Handling: Section 7

LEAD PYROPHOSPHATE
Description: White crystals.
Formula: $Pb_2P_2O_7$
Constants:
  Mol. Wt. 588.38
  M. P. 824°C
  Density 5.8
Toxicity: See Lead Compounds.
Disaster Control: See Lead and Phosphates.
Storage and Handling: Section 7

LEAD, RED. See Lead Oxide.

LEAD RESINATE
Description: Yellowish-white paste.
Formula: $Pb(C_{20}H_{29}O_2)_2$
Constant:
  Mol. Wt. 810.07
Toxicity: See Lead Compounds.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD SELENATE
Description: White crystals.
Formula: $PbSeO_4$
Constants:
  Mol. Wt. 350.17
  M. P. Decomposes
  Density 6.37
Toxicity: See Lead Compounds and Selenium Compounds.
Disaster Control: See Lead and Selenium.
Storage and Handling: Section 7

LEAD SELENIDE
Synonym: Clausthalite.
Description: Cubic crystalline.
Formula: PbSe
Constants:
  Mol. Wt. 286.17
  M. P. 1065°C
  Density 8.10 @15°C
Toxicity: See Lead and Selenium Compounds.
Fire Hazard: Moderate, in the form of dust when exposed to flame or by chemical reaction with moisture to evolve the hydride. See also Hydrogen Selenide.
Explosion Hazard: Slight, by chemical reaction with moisture. See also Hydrogen Selenide.
Disaster Control: See Lead and Selenium.
Storage and Handling: Section 7

LEAD SILICATE. See Lead m-Silicate.

LEAD m-SILICATE
Synonym: Alamosite.
Description: White crystalline powder.
Formula: $PbSiO_3$
Constants:
  Mol. Wt. 283.27
  M. P. 766°C
  Density 6.49
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD STEARATE
Description: White powder.
Formula: $Pb(C_{18}H_{35}O_2)_2$
Constants:
  Mol. Wt. 774.13
  M. P. 115.7°C
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD STYPHNATE. See Lead Trinitroresorcinate.

LEAD SULFATE
Synonym: Anglisite.
Description: White, rhombic crystals.
Formula: $PbSO_4$
Constants:
  Mol. Wt. 303.27
  M. P. Decomposes @1000°C
  Density 6.2
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD SULFIDE

Synonyms: Galena, plumbous sulfide.
Description: Silvery, metallic crystals or black powder.
Formula: PbS
Constants:
  Mol. Wt. 239.27
  M. P. 1114°C
  B. P. 1281°C (sublimes)
  Density 7.5
  Vap. Press. 1 mm @852°C (Sublimes)
Toxicity: See Lead Compounds and Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Lead and Sulfides.
Storage and Handling: Section 7

LEAD SULFITE

Description: White powder.
Formula: $PbSO_3$
Constant:
  Mol. Wt. 287.28
Toxicity: See Lead Compounds and Sulfites.
Disaster Control: See Lead and Sulfites.
Storage and Handling: Section 7

LEAD SULFOCYANATE

Synonym: Lead thiocyanate.
Description: Monoclinic, white crystal.
Formula: $Pb(SCN)_2$
Constants:
  Mol. Wt. 323.37
  Density 3.82
Toxicity: See Lead Compounds and Thiocyanates.
Disaster Control: See Lead and Thiocyanates.
Storage and Handling: Section 7

LEAD TARTRATE

Description: White, crystalline powder.
Formula: $PbC_4H_4O_6$
Constants:
  Mol. Wt. 355.28
  Density 2.53 @19°C
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD TELLURIDE

Synonym: Altaite.
Description: White, cubic crystals.
Formula: PbTe
Constants:
  Mol. Wt. 334.82
  M. P. 917°C
  Density 8.16
Toxicity: See Lead Compounds and Tellurium Compounds.
Disaster Control: See Lead and Tellurium.
Storage and Handling: Section 7

LEAD TETRAACETATE

Description: Colorless to faintly pink, monoclinic crystals.
Formula: $Pb(CH_3COO)_4$
Constants:
  Mol. Wt. 443.39
  M. P. 175°C
  Density 2.228 @17°C
Toxicity: See Lead Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEAD TETRACHLORIDE

Description: Yellow, oily liquid.
Formula: $PbCl_4$
Constants:
  Mol. Wt. 349.04
  M. P. -15°C
  B. P. Explodes @105°C
  Density 3.18 @0°C
Toxicity: See Lead and Hydrochloric Acid. This material readily evolves Hydrochloric Acid in contact with moisture.
Disaster Control: See Lead and Hydrochloric Acid.
Storage and Handling: Section 7

LEAD TETRAETHYL

Description: Colorless, oily liquid, pleasant, characteristic odor.
Formula: $Pb(C_2H_5)_4$
Constants:
  Mol. Wt. 323.5
  M. P. Decomposes 125 - 150°C
  B. P. 198 to 202°C with Decomp.
  Density 1.659 @18°C
  Vap. Press. 1 mm @38.4°C
Toxicity: See Lead Compounds.
Toxicology: This material is a powerful poison and a solvent for fatty materials. It has some solvent action on rubber as well. The fact that it is a lipoid solvent makes it an industrial hazard, because it can cause intoxication not only by inhalation but also by absorption through the skin. It

decomposes when exposed to sunlight or allowed to evaporate, it forms triethyl lead, which is also a poisonous compound, as one of its decomposition products. This liquid lead compound, when handled in undiluted form or concentrated solution as when it is manufactured or in the plants where it is mixed with gasoline, may cause lead exposure intoxication by coming in contact with the skin. Therefore, any open receptacle which contains these liquids in high concentration or any container, article of clothing, or any other object which is not kept clean, particularly in contact with this material, may subject personnel to serious lead exposure.

Fire Hazard: Moderate, when exposed to heat or flame (Section 6).

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of lead; can react vigorously with oxidizing materials.

Storage and Handling: Section 7

LEAD TETRAMETHYL

Description: Colorless liquid.

Formula: $Pb(CH_3)_4$

Constants:
Mol. Wt. 267.33
M. P. -18°F
B. P. 230°F
Density 1.99
Vap. D. 9.2

Toxicity: See Lead Compounds and Lead Tetraethyl.

Fire Hazard: Dangerous, when exposed to heat or flame.

To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Moderate, in the form of vapor when exposed to flame.

Explosive Range: 1.8% (L. E. L.)

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of lead; can react vigorously with oxidizing materials.

Storage and Handling: Section 7

LEAD THIOCYANATE. See Lead Sulfocyanate.

LEAD THIOSULFATE

Synonym: Lead hyposulfite.

Description: White crystals.

Formula: PbS_2O_3

Constants:
Mol. Wt. 319.33
M. P. Decomposes
Density 5.18

Toxicity: See Lead Compounds.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of lead and oxides of sulfur.

Storage and Handling: Section 7

LEAD m-TITANATE

Description: Pale yellow solid.

Formula: $PbTiO_3$

Constants:
Mol. Wt. 303.11
Density 7.52

Toxicity: See Lead Compounds.

Disaster Control: See Lead.

Storage and Handling: Section 7

LEAD TRINITRORESORCINATE

Synonym: Lead styphnate.

Description: Orange-yellow, monoclinic crystals.

Formula: $C_6H(NO_2)_3(O_2Pb)$

Constants:
Mol. Wt. 450.30
M. P. Explodes @590°F
Density 3.1 - 2.9

Toxicity: See Lead Compounds and Nitrates.

Fire Hazard: See Nitrates and Explosives, High.

Explosion Hazard: Severe when heated.

Disaster Control: Dangerous; explodes at 590°F.

Storage and Handling: Section 7

LEAD TUNGSTATE

Synonym: Lead wolframate.

Description: Yellowish powder.

Formula: $PbWO_4$

Constants:
Mol. Wt. 455.13
Density 8.235

Toxicity: See Lead Compounds.

Disaster Control: See Lead.

Storage and Handling: Section 7

LEAD m-VANADATE

Description: Yellow powder.

Formula: $Pb(VO_3)_2$
Constant:
  Mol. Wt. 405.11
Toxicity: See Lead Compounds and Vanadium Compounds.
Disaster Control: See Lead.
Storage and Handling: Section 7

LEATHER

Toxic Hazard Rating:
  Acute Local: Irritant 1; Allergen 1
  Acute Systemic: 0
  Chronic Local: Irritant 1; Allergen 1
  Chronic Systemic: 0
Caution: Handling "green" hides from certain parts of the world can bring about contact with anthrax spores. Furthermore, tanning can introduce materials such as chromium, formaldehyde, etc.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

LEATHER BLEACH

Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride.
Explosion Hazard: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Combustible liquid and inflammable liquid; red label.

LEATHER DRESSING

Constant:
  Flash P. Below 80°F
Toxicity: Details unknown; some dressings may act as irritants or allergens.
Fire Hazard: Dangerous, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Combustible and inflammable liquid; red label.

"LEDATE"

Synonym: Lead dimethyldithiocarbamate.
Description: Gray, no odor.
Formula: $[(CH_3)_2NC(S)S]_2Pb$
Constants:
  Mol. Wt. 447.61
  M. P. Above 258°C
  Density 2.5
Toxicity: See Lead Compounds.
Fire Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of lead and oxides of sulfur; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

"LETHANE 384"

Synonym: β-β-Tubatoxythiocyanodiethyl ether.
Description: Powder.
Toxicity: Details unknown. See also Thiocyanates.
Disaster Control: See Thiocyanates.
Storage and Handling: Section 7

"LETHANE B-71"

Description: Powder.
Toxic Hazard Rating:
  Acute Local: Irritant 1; Allergen 1
  Acute Systemic: Ingestion 1; Inhalation 1
  Chronic Local: Allergen 1
  Chronic Systemic: Ingestion 1; Inhalation 1
Disaster Control: See Thiocyanates.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

LEWISITE

Synonym: Chlorovinyldichloro arsine.
Description: Colorless liquid when pure; geranium-like odor; usually a dark, oily liquid.

Formula: $ClCHCHAsCl_2$
Constants:
Mol. Wt. 207.32
B. P. 190°C Decomposes
Freezing P. −15°C
Density 1.8855 @20°C
Vap. Press. 0.40 mm @20°C
Vap. D. 7.1
Toxic Hazard Rating:
Acute Local: Irritant 3
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Toxicology: A military poison gas (blistering). Median detectable concentration: 8 milligrams per cubic meter of air by irritation and 14 - 23 milligrams per cubic meter of air by odor. Its effects are immediate irritation and delayed blistering. See also Arsenic.
Disaster Control: See Arsenic Compounds.
Ventilation Control (use high rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Poison A; poison gas label - not accepted.
Coast Guard Classification: Poison A; poison gas label.

"LEYTOSAN"
Synonym: Phenyl mercury urea.
Toxicity: See Mercury Compounds, Organic.
Disaster Control: See Mercury Compounds, Organic.
Storage and Handling: Section 7

LIGHT OILS
Constant:
B. P. 230 - 410°F
Toxicity: See Petroleum Hydrocarbons.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7

LIGNITE DUST
Constant: Autoign. Temp. 302°F
Toxic Hazard Rating:
Acute Local: Inhalation 1
Acute Systemic: U
Chronic Local: Inhalation 1
Chronic Systemic: Inhalation 1
MAC: ACGIH (accepted); 50 million particles per cubic foot of air.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use optional): Section 2
Storage and Handling: Section 7

LIME. See Calcium Oxide.

LINSEED OIL
Constants: B. P. 343°C
M. P. −19°C
Density 0.93
Flash P. Raw oil: 432°F (C.C.); boiled: 403°F (C.C.)
Autoign. Temp. 650°F
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1
Acute Systemic: U
Chronic Local: Allergen 2
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: Yes.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

LIQUEFIED CARBON DIOXIDE
Synonym: Liquid carbonic gas.
Description: Heavy gas or liquid under pressure.
Formula: CO_2
Constants:
Mol. Wt. 44.0
M. P. −56.6°C @3952 mm
B. P. −78.5°C Sublimes
Density 1.977 g/l @0°C; liquid: 1.101 @−37°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Inhalation 1
Acute Systemic: Inhalation 1
Chronic Local: 0
Chronic Systemic: Inhalation 1

Disaster Control: Moderately dangerous; shock can shatter the container with explosive force.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Nonflammable gas; green label.
Coast Guard Classification: Noninflammable gas; green gas label.

LIQUEFIED HYDROCARBON GAS

Synonym: LP gas, bottle gas.
Toxicity: Unknown.
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Unknown.
To Fight Fire: Carbon dioxide, dry chemical, or water spray.
Disaster Control: Moderately dangerous; shock can shatter the compressed gas container with explosive force; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable gas; red gas label.
Coast Guard Classification: Inflammable gas; red gas label.

LIQUEFIED NONFLAMMABLE GASES(CHARGED WITH NITROGEN, CARBON DIOXIDE OR AIR)

See specific component.
Shipping Regulations: Section 11.
I.C.C. Classification: Nonflammable gas; green label.
Coast Guard Classification: Noninflammable gas; green gas label.

LITHARGE

Synonyms: Lead oxide, yellow; plumbous oxide; lead protoxide.
Description: Tetragonal, yellow crystals.
Formula: PbO
Constants:
Mol. Wt. 223.21
M. P. 888°C
Density 9.53
Toxicity: See Lead
Disaster Control: See Lead.
Storage and Handling: Section 7

LITHIUM

Description: Silvery light metal.
Formula: Li
Constants:
At. Wt. 6.94
M. P. 186°C
B. P. 1372°C
Density 0.534 @25°C
Vap. Press. 1 mm @723°C
Toxicity: See Lithium Compounds for a discussion of the toxicity of the lithium ion. See Sodium for a discussion which applies to the toxicity of metallic lithium.
Fire Hazard: Dangerous, when exposed to heat or flame or by chemical reaction with moisture, acids or oxidizers.
To Fight Fire: Special mixtures of dry chemical, soda ash, graphite (Section 6).
Explosion Hazard: Dangerous, by chemical reaction with oxidizers, moisture and acids.
Disaster Control: Dangerous; when burned, it emits toxic fumes of lithium oxide and hydroxide; will react with water or steam to produce heat and hydrogen; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

LITHIUM ACETYLSALICYLATE

Description: Slightly hygroscopic powder, decomposes in moist air.
Formula: $LiC_9H_7O_4$
Constant:
Mol. Wt. 186.09
Toxicity: See Acetylsalicylates.
Fire Hazard: Slight, when heated, it emits smoke (Section 6).
Storage and Handling: Section 7

LITHIUM ACID OXALATE

Description: Colorless crystals.
Formula: $LiHC_2O_4 \cdot H_2O$
Constants: Mol. Wt. 113.98
M. P. Decomposes
Toxicity: See Oxalates.

LITHIUM ALUMINATE
Synonym: Lithium m-aluminate.
Description: White powder.
Formula: $LiAlO_2$
Constants:
Mol. Wt. 65.91
M. P. Above 1625°C
Density 2.55 @25°C
Toxicity: See Lithium and Aluminum Compounds.

LITHIUM ALUMINUM DEUTERIDE
Description: White to gray-white micro crystalline lumps or powder.
Formula: $LiAlD_4$
Constants:
Mol. Wt. 42.0
M. P. 150° with decomposition (ignites in air)
Density 1.02 @25°C
Toxicity: See Deuterium, Lithium and Aluminum Compounds.
Fire Hazard: See Hydrides.
Explosion Hazard: See Hydrides.
Disaster Control: See Hydrides.
Storage and Handling: Section 7

LITHIUM ALUMINUM HYDRIDE
Description: White, mocrocrystalline lumps; solid stable in dry air at room temperature; above 125°C decomposes forming Al, H_2 and lithium hydride.
Formula: $LiAlH_4$
Constant:
Mol. Wt. 37.94
Toxicity: See Aluminum and Lithium Compounds.
Fire Hazard: See Hydrides.
Explosion Hazard: See Hydrides.
Disaster Control: See Hydrides.
Storage and Handling: Section 7

LITHIUM ALUMINUM HYDRIDE, ETHEREAL
Description: Liquid solution of $LiAlH_4$ in ether.
Composition: $LiAlH_4$ + an ether.
Toxicity: See Ethyl Ether, Lithium Aluminum Hydride.
Fire Hazard: See Hydrides and Ethers.
To Fight Fire: Special mixtures of dry chemical. See also particular ether used as a solvent.
Explosion Hazard: See Hydrides and Ethers.
Disaster Control: See Ethers and Hydrides.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable liquid; Red label.
Coast Guard Classification: Inflammable liquid; red label.

LITHIUM AMIDE
Description: White crystalline solid or powder.
Formula: $LiNH_2$
Constants: Mol. Wt. 23.0
M. P. 373 - 375°C
B. P. 430°C
Density 1.178 @17.5°C
Toxicity: Ammonia is liberated and lithium hydroxide is formed when this compound is exposed to moisture. See also Ammonia and Lithium Hydroxide.
Fire Hazard: See Ammonia.
Explosion Hazard: See Ammonia.
Disaster Control: Moderately dangerous; will react with water or steam to produce toxic and flammable vapors; on contact with oxidizing materials, it can react vigorously, and on contact with acid or acid fumes, it can evolve much heat.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

LITHIUM ANTIMONIDE
Description: Solid.
Formula: Li_3Sb
Constants:
Mol. Wt. 142.58
M. P. > 950°C
Density 3.2 @17°C
Toxicity: See Antimony Compounds.
Fire Hazard: In contact with moisture stibine is liberated. See also Antimony Hydride.
Explosion Hazard: See Antimony Hydride.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of antimony; will react with water

or steam to produce toxic and flammable vapors; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

LITHIUM ARSENATE
Synonym: Lithium o-arsenate.
Description: White powder.
Formula: Li_3AsO_4
Constants:
Mol. Wt. 159.73
Density 3.07 @15°C
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

LITHIUM BORATE. See Lithium m-Borate.

LITHIUM m-BORATE
Synonym: Lithium borate.
Description: White powder.
Formula: $LiBO_2$
Constants:
Mol. Wt. 49.8
M. P. 845°C
Toxicity: See Boron and Lithium Compounds.

LITHIUM m-BORATE DIHYDRATE. See Lithium m-Borate.

LITHIUM BOROHYDRIDE
Description: White to grayish microcrystalline powder and lumps.
Formula: $LiBH_4$
Constants:
Mol. Wt. 21.8
M. P. 284°C (Decomposes)
Density 0.66
Toxicity: See Boron and Lithium Compounds.
Fire Hazard: See Hydrides.
Explosion Hazard: See Hydrides.
Disaster Control: See Hydrides.
Storage and Handling: Section 7

LITHIUM BROMIDE
Description: White, hygroscopic, granular powder.
Formula: LiBr
Constants:
Mol. Wt. 86.86
M. P. 549°C
B. P. 1265°C
Density 3.46 @25°C
Vap. Press. 1 mm @748°C
Toxicity: See Bromides and Lithium Compounds.

LITHIUM CACODYLATE
Description: White powder.
Formula: $Li(CH_3)_2AsO_2$
Constant:
Mol. Wt. 143.96
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

LITHIUM CARBIDE
Description: Crystals or white powder.
Formula: Li_2C_2
Constants:
Mol. Wt. 37.90
Density 1.65 @18°C
Toxicity: See Lithium Compounds.
Fire Hazard: See Carbides.
Explosion Hazard: See Carbides.
Disaster Control: See Carbides.
Storage and Handling: Section 7

LITHIUM CARBONATE
Formula: Li_2CO_3
Constants:
Mol. Wt. 73.9
M. P. 618°C
Density 2.111 @17.5°C
Toxicity: See Lithium Compounds.

LITHIUM CHLORATE
Description: White crystals.
Formula: $LiClO_3$
Constants:
Mol. Wt. 90.4
M. P. 124°C
B. P. Decomposes @270°C
Toxicity: See Chlorates and Lithium Compounds.
Fire Hazard: See Chlorates.
Explosion Hazard: See Chlorates.
Disaster Control: See Chlorates.
Storage and Handling: Section 7

LITHIUM CHLORIDE
Description: Cubic, white deliquescent crystals.
Formula: LiCl
Constants:
Mol. Wt. 42.4
M. P. 613°C
B. P. 1383°C
Density 2.068 @25°C
Vap. Press. 1 mm @547°C
Toxicity: See Lithium Compounds.
Toxicology: This material has been recommended and used as a substitute for sodium chloride in

"salt free" diets, but cases have been reported in which the ingestion of lithium chloride has produced dizziness, ringing in the ears, visual disturbances, tremors and mental confusion. In most cases, the symptoms disappeared when the use was discontinued.

LITHIUM CHLOROPLATINATE
Description: Red, deliquescent crystals.
Formula: $Li_2PtCl_6 \cdot 6H_2O$
Constants:
Mol. Wt. 529.95
B. P. $-6H_2O$ @180°C
Toxicity: See Platinum Compounds.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits fumes of chlorine and chlorine compounds.
Storage and Handling: Section 7

LITHIUM CHROMATE
Description: Yellow crystalline, deliquescent powder.
Formula: $Li_2CrO_4 \cdot 2H_2O$
Constants:
Mol. Wt. 165.92
M. P. $-2H_2O$ @150°C
Toxicity: See Chromium Compounds.
Fire Hazard: Slight; an oxidizer. It can react with reducing materials (Section 6).
Storage and Handling: Section 7

LITHIUM COBALTITE
Description: Blue-black powder.
Formula: $LiCoO_2$
Constant:
Mol. Wt. 97.9
Toxicity: See Cobalt Compounds.

LITHIUM COMPOUNDS
Toxic Hazard Rating:
- Acute Local: Ingestion 1; Inhalation 1
- Acute Systemic: Ingestion 2; Inhalation 2
- Chronic Local: U
- Chronic Systemic: Ingestion 1; Inhalation 1

Toxicology: Lithium compounds resemble those of Potassium in systemic and local action. Large doses of lithium compounds have caused dizziness and prostration. Lithium oxide, hydroxide, carborate, etc., are strong bases and these solutions in water are very caustic. See also Potassium Compounds.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3

LITHIUM DEUTERIDE
Description: Bluish-gray, fine powder.
Formula: LiD
Constants:
Mol. Wt. 9.0
M. P. Above 600°C
Density 0.906 @25°C
Toxicity: See Deuterium and Lithium Compounds.
Fire Hazard: See Hydrides.
Explosion Hazard: See Hydrides.
Disaster Control: See Hydrides.
Storage and Handling: Section 7

LITHIUM DICHROMATE
Synonym: Lithium bichromate.
Description: Yellowish-red, crystalline, deliquescent powder.
Formula: $Li_2Cr_2O_7 \cdot 2H_2O$
Constants: Mol. Wt. 265.93
M. P. $-2H_2O$ @130°C
B. P. Decomposes.
Toxicity: See Chromium Compounds.
Fire Hazard: Moderate, a powerful oxidizer; can react with reducing materials (Section 6).
Storage and Handling: Section 7

LITHIUM ETHYL
Description: Transparent crystals.
Formula: LiC_2H_5
Constants:
Mol. Wt. 36.00
M. P. 95°C
Toxicity: See Lithium Compounds.
Fire Hazard: A flammable material; can react with oxidizing materials (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

LITHIUM FLUORIDE
Description: Fine white powder.
Formula: LiF
Constants:
Mol. Wt. 25.94
M. P. 845°C
B. P. 1671°C

Density 2.295 @21.5°C
Vap. Press. 1 mm @1047°C
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

LITHIUM FLUOSILICATE

Synonym: Lithium silicofluoride.
Description: Monoclinic, white crystals.
Formula: $Li_2SiF_6 \cdot 2H_2O$
Constants:
Mol. Wt. 191.97
M. P. $-2H_2O$ @100°C
B. P. Decomposes
Density 2.33 @12°C
Toxicity: See Fluosilicates.
Disaster Control: See Fluosilicates.
Storage and Handling: Section 7

LITHIUM GALLIUM HYDRIDE

Description: White crystals.
Formula: $LiGaH_4$
Constant:
Mol. Wt. 80.69
Toxicity: See Gallium and Lithium Compounds.
Fire Hazard: See Hydrides.
Explosion Hazard: See Hydrides
Disaster Control: See Hydrides.
Storage and Handling: Section 7

LITHIUM GALLIUM NITRIDE

Description: Light gray powder.
Formula: Li_3GaN_2
Constants:
Mol. Wt. 118.56
M. P. Decomposes @800°C
Density 3.35
Toxicity: See Gallium and Lithium Compounds.
Fire Hazard: See Ammonia.
Explosion Hazard: See Ammonia.

LITHIUM m- GERMANATE

Description: Crystals.
Formula: Li_2GeO_3
Constants:
Mol. Wt. 134.48
M. P. 1239°C
Density 3.53 @21°C
Toxicity: See Germanium and Lithium Compounds.

LITHIUM HYDRIDE

Description: White, translucent, crystalline mass.
Formula: LiH
Constants:
Mol. Wt. 7.95
M. P. 680°C
Density 0.82
Toxicity: In contact with moisture lithium hydroxide is formed. Can ignite spontaneously in moist air. See also Lithium Compounds.
Fire Hazard: See Hydrides.
To Fight Fire: Special mixtures of dry chemical.
Explosion Hazard: See Hydrides.
Disaster Control: See Hydrides.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

LITHIUM HYDROSULFIDE

Description: White, hygroscopic powder.
Formula: LiHS
Constant:
Mol. Wt. 40.01
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

LITHIUM HYDROXIDE

Description: Colorless crystals.
Formula: LiOH
Constants:
Mol. Wt. 23.95
M. P. 462°C
B. P. Decomposes
Density 2.54 @20°C
Toxicity: See Lithium Compounds and Sodium Hydroxide.

LITHIUM HYDROXIDE MONOHYDRATE. See Lithium Hydroxide.

LITHIUM IODATE

Description: White crystals.
Formula: $LiIO_3$
Constant:
Mol. Wt. 181.86
Toxicity: See Iodates and Lithium Compounds.
Fire Hazard: See Iodates.
Explosion Hazard: See Iodates.
Disaster Control: See Iodates.
Storage and Handling: Section 7

LITHIUM MANGANITE
Description: Reddish-brown powder.
Formula: Li_2MnO_3
Constant:
Mol. Wt. 116.8
Toxicity: See Manganese and Lithium Compounds.

LITHIUM METAL, IN CARTRIDGES.
See Lithium.
Shipping Regulations: Section 11.
I. C. C. Classification: See §73.206
Coast Guard Classification: Inflammable solid; yellow label.

LITHIUM MOLYBDATE
Description: White, crystalline powder.
Formula: Li_2MoO_4
Constants:
Mol. Wt. 173.83
M. P. 705°C
Toxicity: See Molybdenum and Lithium Compounds.

LITHIUM NITRATE
Description: Colorless powder, deliquescent granules.
Formula: $LiNO_3$
Constants:
Mol. Wt. 69.0
M. P. 255°C
Density 2.38
Toxicity: See Nitrates.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

LITHIUM NITRITE
Description: Colorless crystals.
Formula: $LiNO_2 \cdot H_2O$
Constants:
Mol. Wt. 71.0
M. P. < 100°C
B. P. Decomposes
Density 1.615 @0°C
Toxicity: See Nitrites.
Fire Hazard: See Nitrites.
Explosion Hazard: See Nitrites.
Disaster Control: See Nitrites.
Storage and Handling: Section 7

LITHIUM OXALATE
Description: Colorless crystals.
Formula: $Li_2C_2O_4$
Constants:
Mol. Wt. 101.90
M. P. Decomposes
Density 2.121 @17.5°C
Toxicity: See Oxalates.

LITHIUM OXIDE
Description: Cubic, white crystals.
Formula: Li_2O
Constants:
Mol. Wt. 29.9
M. P. > 1700°C
Density 2.013 @25.2°C
Toxicity: See Lithium Compounds.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3

LITHIUM PERCHLORATE
Description: Colorless, deliquescent crystals.
Formula: $LiClO_4$
Constants:
Mol. Wt. 106.40
M. P. 239°C
B. P. Decomposes @380°C
Density 2.429
Toxicity: See Perchlorates.
Fire Hazard: See Perchlorates.
Explosion Hazard: See Perchlorates.
Disaster Control: See Perchlorates.
Storage and Handling: Section 7

LITHIUM PERMANGANATE
Description: Purple crystals.
Formula: $LiMnO_4 \cdot 3H_2O$
Constants:
Mol. Wt. 179.92
M. P. Decomposes @190°C
Density 2.06
Toxicity: See Manganese Compounds.
Fire Hazard: Moderate; a powerful oxidizing agent; can react with reducing materials (Section 6).
Storage and Handling: Section 7

LITHIUM PEROXIDE
Description: Fine white powder or a sandy yellow, granular material.
Formula: Li_2O_2
Constants:
Mol. Wt. 45.88
M. P. Decomposes
Density 2.14 @20°C
Toxicity: See Lithium Compounds and Peroxides.
Fire Hazard: Dangerous, because it is an extremely powerful oxidizing agent. See also Peroxides, Inorganic.

Disaster Control: Moderately dangerous; will react with water or steam to produce heat; on contact with reducing material, it can react vigorously.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

LITHIUM SELENIDE

Description: Colorless, deliquescent crystals.
Formula: $Li_2Se \cdot 9H_2O$
Constant:
Mol. Wt. 255.0
Toxicity: See Selenium Compounds.
Fire Hazard: See Hydrogen Selenide.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

LITHIUM SILICATE

Description: White powder.
Formula: Li_2SiO_3
Constants:
Mol. Wt. 89.9
M. P. 1201°C
Density 2.52 @25°C
Toxicity: See Silicates.

LITHIUM SILICON

Description: Solid.
Composition: Li + Si.
Toxicity: See Lithium and Silicon.
Fire Hazard: Dangerous, in the form of dust when exposed to heat or flame or by chemical reaction with moisture or acids. In contact with water, silane and hydrogen are evolved.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Slight, in the form of dust when exposed to flame. See also Powdered Metals.
Disaster Control: Moderately dangerous; will react with water or steam to produce flammable vapors; on contact with oxidizing materials, it can react vigorously and on contact with acid or acid fumes, it can emit toxic and flammable fumes.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

LITHIUM SODIUM FLUOALUMINATE

Description: Cubic crystals.
Formula: $Li_3Na_3(AlF_6)_2$
Constants:
Mol. Wt. 371.75
M. P. 710°C
Density 2.774
Toxicity: See Fluoaluminates.
Disaster Control: See Fluoaluminates.
Storage and Handling: Section 7

LITHIUM SULFIDE

Description: Cubic, white-yellow crystals.
Formula: Li_2S
Constants:
Mol. Wt. 46.0
Density 1.66
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

LITHIUM SULFITE

Description: Needles.
Formula: $Li_2SO_3 \cdot H_2O$
Constants:
Mol. Wt. 112.0
M. P. 455°C slight decomp.
Toxicity: See Sulfites.
Disaster Control: See Sulfites.
Storage and Handling: Section 7

LITHIUM TETRABORATE

Description: White, crystalline powder.
Formula: $Li_2B_4O_7 \cdot 5H_2O$
Constants:
Mol. Wt. 259.24
M. P. $-2H_2O$ @200°C
Toxicity: See Boron and Lithium Compounds.

LITHIUM THALLIUM dl-TARTRATE

Description: Crystals.
Formula: $LiTlC_4H_2O_6 \cdot 2H_2O$
Constants: Mol. Wt. 395.43
Density 3.144
Toxicity: See Thallium Compounds.
Disaster Control: See Thallium Compounds.
Storage and Handling: Section 7

LITHIUM THIOCYANATE
Description: Deliquescent, white crystals.
Formula: LiSCN
Constant:
Mol. Wt. 65.0
Toxicity: See Thiocyanates.
Disaster Control: See Thiocyanates.
Storage and Handling: Section 7

LITHIUM m-VANADATE
Description: Yellowish powder.
Formula: $LiVO_3 \cdot 2H_2O$
Constant:
Mol. Wt. 141.92
Toxicity: See Vanadium Compounds.

LITHIUM ZIRCONATE
Description: Creamy-white powder.
Formula: Li_2ZrO_3
Constant:
Mol. Wt. 153.10
Toxicity: See Zirconium and Lithium Compounds.

LITHIUM ZIRCONIUM SILICATE
Description: White powder.
Formula: $2Li_2O \cdot ZrO_2 \cdot SiO_2$
Constant: Mol. Wt. 243.0
Toxicity: See Lithium Compounds, Zirconium Compounds and Silicates.

LOBELIA
Toxicity: See Lobeline.
Disaster Control: Dangerous; when heated, it emits highly toxic fumes.
Storage and Handling: Section 7

LOBELINE
Description: Yellow, syrupy liquid.
Formula: $C_{22}H_{27}NO_2$
Constants:
Mol. Wt. 285.28
M. P. 131°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Toxicology: Causes stimulation which leads to convulsions in severe cases. Nausea and vomiting are frequent.
Treatment and Antidotes: Wash out Stomach if vomiting has not occurred. Use stimulants.
Disaster Control: Dangerous; when heated, it emits highly toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

LOBELINE SULFATE
Toxicity: See Lobeline.

LOGWOOD
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

LOMITE #1. See Explosives, High.

LONDON PURPLE, SOLID. See Arsenic Compounds and Aniline.
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

LOW EXPLOSIVES. See Explosives, Low.
Shipping Regulations: Section 11.
I. C. C. Classification: Explosive A - not accepted.
Coast Guard Classification: Explosive A.

LUBRICATING OIL
Constants:
Flash P. 450 - 535°F (O. C.)
Density Less than 1.00
Autoign. Temp. 783°F
Toxicity: Details unknown. See also Petroleum Hydrocarbons.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Spray, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

LUBRICATING OIL, CYLINDER
Constant:
Density < 1
Toxicity: Details unknown. See also Petroleum Hydrocarbons.

Fire Hazard: Slight when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water spray, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

LUBRICATING OIL (MAINLY MINERAL)

Constants:
Density < 1
Autoign. Temp. 700 °F
Flash P. 300 - 450 °F
Toxicity: Details unknown. See also Petroleum Hydrocarbons.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water spray, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

LUBRICATING OIL, MINERAL

Constant:
Density < 1
Toxicity: Details unknown. See also Petroleum Hydrocarbons.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water spray, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

LUBRICATING OIL, MOTOR

Constants:
Density < 1
Autoign. Temp. 500 - 700 °C
Flash P. 300 - 450 °F
Toxicity: Details unknown. See also Petroleum Hydrocarbons.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water spray, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

LUBRICATING OILS, AUTO

Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1; Ingestion 1
Acute Systemic: 0
Chronic Local: Allergen 1
Chronic Systemic: 0
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

LUBRICATING OIL, SPINDLE

Constants:
Density < 1
Autoign. Temp. 478 °F
Flash P. 169 °F
Toxicity: Details unknown. See also Petroleum Hydrocarbons.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water spray, foam carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

LUBRICATING OIL, TURBINE

Constants:
Density < 1
Autoign. Temp. 700 °F
Flash P. 400 °F (O.C.)
Toxicity: Details unknown. See also Petroleum Hydrocarbons.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water spray, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

"LUCITE." See Methyl Methacrylate.

"LUMINAL"

Synonyms: Phenylethylbaribituric acid; phenylethylmalonylurea.
Description: White, shining, crystalline, odorless and stable powder.
Formula:
$(C_6H_5)(C_2H_5)C(CONH)_2CO$
Constants:
Mol. Wt. 232.17
M. P. 174 - 178 °C
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: Ingestion 2
Chronic Local: Allergen 1
Chronic Systemic: Ingestion 2
Fire Hazard: Unknown

Disaster Control: Slightly dangerous; when heated, it emits acrid fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

LUPANINE

Description: White needles (dextroform); yellow syrupy liquid (levoform).
Formula: $C_{15}H_{24}N_2O$
Constants:
Mol. Wt. 248.28
M. P. 40°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Disaster Control: Slightly dangerous; when heated to decomposition it emits highly toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

"LUPERCO"

Description: Paste or solution in organic or inorganic solvents.
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate; a powerful oxidizing agent; can react with reducing materials (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

"LUPERSOL"

Description: Solutions.
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate; a powerful oxidizing agent; can react with reducing materials (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

LUPININE

Description: White, crystalline alkaloid.
Formula: $C_{10}H_{19}NO$
Constants:
Mol. Wt. 169.21
M. P. 69 - 71°C
B. P. 255 - 257°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated, it emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

LUTETIUM

Formula: Lu
Constant:
At. Wt. 175.0
Toxicity: Unknown
Radiation Hazard: Natural isotope Lu^{176}; emits beta particles of 0.3 mev and gamma rays of 0.26 mev. Artificial isotope Lu^{177}, half-life: 6.8 days; emits beta particles of 0.37 mev (17%), 0.17 mev (18%) and 0.50 mev (65%) and gamma rays of 0.11, 0.21 and 0.32 mev. The permissible levels are: In body: 78 microcuries; in air: 5×10^{-6} microcurie per milliliter; in water: 24 microcurie per milliliter.
Fire Hazard: Moderate in the form of dust when exposed to heat or flame or by chemical reaction with oxidizers.
Explosion Hazard: See Powdered Metals.
Storage and Handling: Section 7

2,6-LUTIDINE

Synonym: 2,6-Dimethyl pyridine.

Description: Liquid.
Formula: $(CH_3)_2C_5H_3N$
Constants:
  Mol. Wt. 107.1
  B. P. 143.7°C
  Freezing P. −6.6°C
  Density 0.923 @20°C
  Vap. D. 3.70
Toxicity: Details unknown. See Pyridine.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

LYCORINE

Description: White, crystalline alkaloid.
Formula: $C_{16}H_{17}NO_4$
Constants:
  Mol. Wt. 287.31
  M. P. 280°C (decomp.)
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3

LYE. See Sodium Hydroxide.

M

MAGNESIUM

Description: Hexagonal, silvery-white crystals of metal.

Formula: Mg

Constants:

At. Wt. 24.32
M. P. 651°C
B. P. 1107°C
Density 1.74 @5°C
Vap. Press. 1 mm @621°C

Toxicity: See Magnesium Compounds.

Fire Hazard: Dangerous, in the form of dust or flakes, when exposed to flame, or by violent chemical reaction with oxidizing agents. In solid form, magnesium is difficult to ignite because heat is conducted rapidly away from the source of ignition; it must be heated above its melting point before it will burn. However, in finely divided form it may be ignited by a spark or the flame of a match. Magnesium fires do not flare up violently unless there is moisture present. Therefore, it must be kept away from water, moisture, etc. See also Powdered Metals.

To Fight Fire: Operators and fire fighters can approach a magnesium fire to within a few feet if no moisture is present. Water and other ordinary extinguishers, such as CO_2, carbon tetrachloride, etc., should not be used on magnesium fires. G-1 powder or powdered talc should be used on open fires. Oven fires can be easily controlled by the use of boron trichloride gas.

Magnesium turnings, borings, etc., should be collected frequently during the working hours and always at the end of the shift from machines and surrounding area and placed in clean, dry metal covered containers plainly labeled, "For Magnesium Only." Good housekeeping is essential. If more than 50 cubic feet (6 fifty-gallon drums) of turnings, borings, etc., are allowed to accumulate, it is necessary that they be left in drums and removed to a separate fire resistant storage room or separated from other occupancies by a space of at least 50 feet. Magnesium grinding dust should always be collected in a dust collector approved specifically for this service. The collected material should be removed frequently, and burned. This may be accomplished by spreading it three or four inches thick on a layer of firebrick or hard burnt paving brick and igniting some combustible refuse placed on top. The burning refuse ignites the top surface of the magnesium and the layer dries as it burns. Danger of a sudden flare up exists when the sludge has been allowed to become partially dry.

During machining, magnesium fires result from the use of dull cutting tools, machining with light cuts at high speeds, or rubbing of the tool on the work after the cutting operation is finished. Chip fires on machine tools can best be controlled by the use of a newly developed liquid extinguishant, by flooding with coolant, by using G-1 powder or powdered talc, or, if necessary, by dry sand. These dry materials should be shoveled onto a fire until it is completely blanketed. If the fire is on a combustible floor, best results can be obtained by spreading a layer of extinguishing material on the floor and on the fire, and then shoveling the fire on the layer of extinguishing material.

Explosion Hazard: Moderate, in the form of dust, when exposed to flame or by violent chemical reaction with powerful oxidizers.

See also Powdered Metals.
Disaster Control: Dangerous; when heated, it burns violently in air and emits fumes; will react with water or steam to produce hydrogen; on contact with oxidizing materials, it can react vigorously.

MAGNESIUM o-ARSENATE
Synonym: Hoernesite.
Description: Monoclinic, white crystals.
Formula: $Mg_3(AsO_4)_2 \cdot 8H_2O$
Constants:
Mol. Wt. 494.91
Density 2.60 - 2.61
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
MCA warning label.

MAGNESIUM ARSENATE, SOLID.
See Magnesium o-Arsenate.
Shipping Regulations: Section 11.
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.
MCA warning label.

MAGNESIUM o-ARSENITE
Description: Solid.
Formula: $Mg_3(AsO_3)_2$
Constant:
Mol. Wt. 318.78
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

MAGNESIUM o-BORATE
Description: Rhombic, colorless crystals.
Formula: $Mg_3(BO_3)_2$
Constants:
Mol. Wt. 190.60
Density 2.99 @21°C
Toxicity: See Boron Compounds and Magnesium.

MAGNESIUM BROMATE
Description: Colorless crystals.
Formula: $Mg(BrO_3)_2 \cdot 6H_2O$
Constants:
Mol. Wt. 388.25
M. P. $-6H_2O$ @200°C
B. P. Decomposes
Density 2.29
Toxicity: See Bromates.
Fire Hazard: See Bromates.
Explosion Hazard: See Bromates.
Disaster Control: See Bromates.
Storage and Handling: Section 7

MAGNESIUM BROMIDE
Description: Large lustrous, white, deliquescent crystals.
Formula: $MgBr_2$
Constants:
Mol. Wt. 184.15
M. P. 700°C
Density 3.72
Toxicity: See Bromides.

MAGNESIUM BROMOPLATINATE
Description: Trigonal crystals.
Formula: $MgPtBr_6 \cdot 12H_2O$
Constants:
Mol. Wt. 915.24
Density 2.802
Toxicity: See Platinum Compounds.

MAGNESIUM CHLORATE
Description: White, deliquescent crystals or powder.
Formula: $Mg(ClO_3)_2 \cdot 6H_2O$
Constants:
Mol. Wt. 299.33
M. P. 35°C
B. P. Decomposes @120°C
Density 1.80 @25°C
Toxicity: See Magnesium Compounds.
Fire Hazard: See Chlorates.
Explosion Hazard: See Chlorates.
Disaster Control: See Chlorates.
Storage and Handling: Section 7

MAGNESIUM CHLORIDE
Description: Thin white to gray opaque granules and/or flakes.
Formula: $MgCl_2$
Constants: Mol. Wt. 95.2
M. P. 708°C
B. P. 1412°C
Density 2.325
Toxicity: See Magnesium Compounds.
Disaster Control: See Chlorides.
Storage and Handling: Section 7

MAGNESIUM CHLORIDE, HYDRATED.
See Magnesium Chloride.

MAGNESIUM CHLOROPALLADATE
Description: Hexagonal crystals.

Formula: $MgPdCl_6 \cdot 6H_2O$
Constants:
  Mol. Wt. 451.86
  M. P. Decomposes
  Density 2.12
Toxicity: See Palladium Compounds and Magnesium Compounds.
Disaster Control: See Chlorides.
Storage and Handling: Section 7

MAGNESIUM CHLOROPLATINATE

Description: Crystals.
Formula: $MgPtCl_6 \cdot 6H_2O$
Constants:
  Mol. Wt. 540.39
  M. P. Decomposes
  Density 2.437
Toxicity: See Platinum Compounds and Magnesium Compounds.
Disaster Control: See Chlorides.
Storage and Handling: Section 7

MAGNESIUM CHLOROSTANNATE

Description: Crystals.
Formula: $MgSnCl_6 \cdot 6H_2O$
Constants:
  Mol. Wt. 463.86
  M. P. Decomposes @100°C
  Density 2.08
Toxicity: See Tin Compounds and Magnesium Compounds.
Disaster Control: See Chlorides.
Storage and Handling: Section 7

MAGNESIUM CHROMATE

Description: Rhombic, yellow crystals.
Formula: $MgCrO_4 \cdot 7H_2O$
Constants:
  Mol. Wt. 266.44
  Density 1.695
Toxicity: See Chromium Compounds and Magnesium Compounds.
Fire Hazard: Slight, by chemical reaction; can react with reducing materials (Section 6).
Storage and Handling: Section 7

MAGNESIUM COMPOUNDS

Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 1
    Inhalation 2
  Chronic Local: Irritant 2
  Chronic Systemic: U
MAC: ACGIH (accepted); 10 parts per million in air; 15 milligrams (as MgO fume) per cubic meter of air.
Toxicology: The inhalation of fumes of freshly sublimed magnesium oxide may cause metal fume fever. There is no evidence that magnesium produces true systemic poisoning. Occupational health hazards may exist in magnesium foundries, probably from the presence of atmospheric contaminants such as fluorides, sulfur dioxide, carbon tetrachloride and chromium compounds.

Particles of metallic magnesium or magnesium alloy which perforate the skin or gain entry through cuts and scratches may produce a severe local lesion characterized by the evolution of gas and acute inflammatory reaction, frequently with necrosis. The condition has been called a "chemical gas gangrene." Gaseous blebs may develop within 24 hours of the injury. The inflammatory response is marked at the site of injury and there may be signs of lymphangitis. The lesion is very slow to heal.

The most serious hazard presented by magnesium is the danger from burns. Protection necessary for personnel handling and processing magnesium is usually no different from that which is necessary for other metals. It is recommended that smooth clothing and leather or fire resistant, easily removable aprons be worn in grinding operations on magnesium. The toxicity of magnesium compounds is usually that of the anion. Refer to magnesium and anion. See also specific compounds.

MAGNESIUM CYANIDE

Description: Solid.
Formula: $Mg(CN)_2$
Constant:
  Mol. Wt. 76.4
Toxicity: Highly toxic. See Cyanides.
Fire Hazard: See Cyanides.
Explosion Hazard: See Cyanides.
Disaster Control: See Cyanides.

MAGNESIUM DIAMIDE

Description: White powder.
Formula: $Mg(NH_2)_2$

Constants:
Mol. Wt. 56.4
M. P. Decomposes
Toxicity: Details unknown. See also Ammonia, which is evolved upon contact with water.
Fire Hazard: Dangerous; by chemical reaction to evolve ammonia; spontaneously flammable in air (Section 6).
Explosion Hazard: Moderate, by spontaneous chemical reaction; reacts violently with water.
Disaster Control: Dangerous; will react with water or steam to produce toxic and flammable vapors; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

MAGNESIUM DIETHYL

Description: Crystals or liquid.
Formula: $Mg(C_2H_5)_2$
Constants:
Mol. Wt. 82.4
M. P. 0°C
Toxicity: Details unknown. See also Magnesium and Ethyl Alcohol.
Fire Hazard: Dangerous; spontaneously flammable in air or in carbon dioxide (Section 6).
Explosion Hazard: Moderate, by spontaneous chemical reaction or upon contact with water.
Disaster Control: Dangerous; will react violently with water or steam; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

MAGNESIUM DIPHENYL

Description: Feathery crystals.
Formula: $Mg(C_6H_5)_2$
Constant:
Mol. Wt. 178.5
Toxicity: Unknown
Fire Hazard: Moderate; spontaneously flammable in moist (but not dry) air (Section 6).
Explosion Hazard: Moderate, when exposed to flame, or upon contact with moisture.
Disaster Control: Moderately dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits toxic fumes; decomposes violently in water; can react with oxidizing materials.
Storage and Handling: Section 7

MAGNESIUM DUST. See Magnesium.

MAGNESIUM ETHYLENE BIS-DITHIOCARBAMATE

Toxicity: Details unknown; a skin irritant.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

MAGNESIUM FERROCYANIDE

Description: Pale yellow crystals.
Formula: $Mg_2Fe(CN)_6 \cdot 12H_2O$
Constants:
Mol. Wt. 476.79
M. P. Decomp. @approx. 200°C
Toxicity: See Ferrocyanides.
Disaster Control: See Ferrocyanides.
Storage and Handling: Section 7

MAGNESIUM FLUORIDE

Synonym: Sellaite.
Description: Faint violet, luminous crystals.
Formula: MgF_2
Constants:
Mol. Wt. 62.32
M. P. 1396°C
B. P. 2239°C
Density 2.9 - 3.2
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

MAGNESIUM FLUOSILICATE

Description: White crystals or powder.
Formula: $MgSiF_6$
Constant:
Mol. Wt. 166.38
Toxicity: See Fluosilicates.
Disaster Control: See Fluosilicates.
Storage and Handling: Section 7

MAGNESIUM FORMATE

Description: Rhombic, colorless crystals.
Formula: $Mg(CHO_2)_2 \cdot 2H_2O$
Constant:
Mol. Wt. 150.4
Toxicity: See Formic Acid.
Fire Hazard: Slight; when heated,

it emits acrid fumes.
Storage and Handling: Section 7

MAGNESIUM o-GERMANATE
Description: White precipitate.
Formula: Mg_2GeO_4
Constant:
Mol. Wt. 185.24
Toxicity: See Germanium Compounds.

MAGNESIUM HYPOPHOSPHITE
Description: White crystals.
Formula: $Mg(H_2PO_2)_2 \cdot 6H_2O$
Constants:
Mol. Wt. 262.36
Density 1.59
Toxicity: See Hypophosphites.
Fire Hazard: Moderate, when exposed to heat.
Explosion Hazard: Moderate, by chemical reaction.
Disaster Control: Dangerous; when heated to 100°C it evolves flammable gas and highly toxic fumes of phosphine; can react with oxidizing materials.
Storage and Handling: Section 7

MAGNESIUM IODATE
Description: Colorless crystals.
Formula: $Mg(IO_3)_2 \cdot 4H_2O$
Constants:
Mol. Wt. 446.22
M. P. $-4H_2O$ @210°C
B. P. Decomposes
Density 3.3 @13.5°C
Toxicity: See Iodates and Magnesium Compounds.
Fire Hazard: See Iodates.
Disaster Control: See Iodates.
Storage and Handling: Section 7

MAGNESIUM IODIDE
Description: White, deliquescent crystals.
Formula: MgI_2
Constants:
Mol. Wt. 278.16
M. P. > 700°C Decomposes.
Density 4.244
Toxicity: See Iodides and Magnesium Compounds.
Disaster Control: See Iodides.
Storage and Handling: Section 7

MAGNESIUM NITRATE
Description: (1) white crystals (prisms); (2) monoclinic, colorless, deliquescent crystals.
Formula: (1) $Mg(NO_3)_2 \cdot 2H_2O$; (2) $Mg(NO_3)_2 \cdot 6H_2O$
Constants:
Mol. Wt. (1) 184.37; (2) 256.43.
Density (1) 2.0256 @25°C; (2) 1.464
M. P. (1) 129.0°C; (2) 95°C
B. P. (2) $-5H_2O$ @330°C
Toxicity: See Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material.

MAGNESIUM OXALATE
Description: White powder.
Formula: $MgC_2O_4 \cdot 2H_2O$
Constants:
Mol. Wt. 148.37
M. P. Decomposes
Density 2.45
Toxicity: See Oxalates.

MAGNESIUM OXIDE
Description: White powder.
Formula: MgO
Constants:
Mol. Wt. 40.32
M. P. 2500 - 2800°C
Density 3.65 - 3.75
Toxicity: See Magnesium Compounds.
MCA: ACGIH (accepted); 15 milligrams per cubic meter of air.

MAGNESIUM PERBORATE
Description: White powder.
Formula: $Mg(BO_3)_2 \cdot 7H_2O$
Constant:
Mol. Wt. 268.02
Toxicity: See Magnesium Compounds and Boron Compounds.
Fire Hazard: Slight, by chemical reaction; an oxidant (Section 6).
Storage and Handling: Section 7

MAGNESIUM PERCHLORATE
Description: White, hygroscopic crystals.
Formula: $Mg(ClO_4)_2$
Constants:
Mol. Wt. 223.33
M. P. Decomp. @251°C
Density 2.60 @25°C

Toxicity: See Magnesium Compounds and Perchlorates.
Fire Hazard: See Perchlorates.
Explosion Hazard: See Perchlorates.
Disaster Control: See Perchlorates.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

MAGNESIUM PERMANGANATE

Description: Dark purple, deliquescent needles.
Formula: $Mg(MnO_4)_2 \cdot 6H_2O$
Constants:
Mol. Wt. 370.28
M. P. Decomposes
Density 2.18
Toxicity: See Manganese Compounds.
Fire Hazard: Moderate, by chemical reaction; a powerful oxidizer (Section 6).
Storage and Handling: Section 7

MAGNESIUM PEROXIDE

Synonym: Magnesium dioxide.
Description: White powder.
Formula: MgO_2 (theoretical)
Constant:
Mol. Wt. 56.32
Toxicity: See Peroxides, Inorganic and Magnesium Compounds.
Fire Hazard: Moderate, by chemical reaction with acidic materials and moisture; an oxidizing agent (Section 6).
Disaster Control: Dangerous; can react with reducing agents; will decompose violently in or near a fire.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

MAGNESIUM RICINOLEATE

Description: Coarse white granules.
Formula: $Mg[CO_2(CH_2)_7CH = CHCH_2\text{-}CHOH(CH_2)_5CH_3]_2$
Constants:
Mol. Wt. 614
M. P. 95°C
Density 1.06 @25°/25°C
Toxicity: See Magnesium Compounds.
Storage and Handling: Section 7

MAGNESIUM SCRAP (SHAVINGS, BORINGS, OR TURNINGS).

See Magnesium.
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

MAGNESIUM SELENATE

Description: Colorless crystals.
Formula: $MgSeO_4 \cdot 6H_2O$
Constants:
Mol. Wt. 275.38
Density 1.928
Toxicity: See Selenium Compounds.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

MAGNESIUM SILICATE HYDRATED.

See Asbestos.

MAGNESIUM SILICATE, HYDROUS

Description: Solid.
Formula: $Mg_2Si_3O_8 \cdot 5H_2O$
Toxicity: See Silicates.

MAGNESIUM SULFATE

Synonym: Epsom Salt.
Description: Opaque needles.
Formula: $MgSO_4 \cdot 7H_2O$
Constants:
Mol. Wt. 246.5
M. P. $-7H_2O$ @200°C
Density 1.68
Toxicity: See Magnesium Compounds.

MAGNESIUM SULFIDE

Description: Pale red to reddish-brown.
Formula: MgS
Constants:
Mol. Wt. 56.39
M. P. Decomposes
Density 2.79 - 2.85
Toxicity: See Magnesium Compounds and Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

MAGNESIUM SULFITE

Description: White crystalline powder.
Formula: $MgSO_3 \cdot 6H_2O$

Constants:
  Mol. Wt. 212.48
  M. P. $-6H_2O$ @200°C
  B. P. Decomposes
  Density 1.725
Toxicity: See Magnesium Compounds and Sulfites.
Disaster Control: See Sulfites.
Storage and Handling: Section 7

MAGNESIUM THIOTELLURITE

Description: Pale yellow, crystalline mass.
Formula: Mg_3TeS_5
Constant:
  Mol. Wt. 360.9
Toxicity: See Sulfides and Tellurium Compounds.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur and tellurium; can react with oxidizing materials.
Storage and Handling: Section 7

MAGNESIUM TUNGSTATE

Description: Colorless, monoclinic crystals.
Formula: $MgWO_4$
Constants:
  Mol. Wt. 272.24
  Density 5.66
Toxicity: See Magnesium Compounds and Tungsten Compounds.

MALACHITE GREEN

Synonyms: Aniline green; China green.
Description: Green crystals.
Formula:
  $C_{23}H_{25}N_2Cl$
Constant:
  Mol. Wt. 364.9
Toxicity: Details unknown. See also Aniline Dyes.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of aniline and oxides of nitrogen.
Storage and Handling: Section 7

MALATHION

Synonym: O,O-Dimethyl dithiophosphate of diethyl mercaptosuccinate.
Description: Yellow-brown liquid.
Formula:
  $(CH_3)_2PSSCHCOOC_2H_5CH_2COOC_2H_5$
Constants:
  Mol. Wt. 298.4
  Vap. D. 10.3
  Density 1.23 @25°C
Toxicity: See Parathion.
MAC: ACGIH (tentative): 15 milligrams per cubic meter of air.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur and phosphorus.
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

MALEIC ACID

Synonyms: Maleinic acid; toxilic acid.
Description: White crystals, faint acidulous odor.
Formula: HOOCCHCHCOOH
Constants:
  Mol. Wt. 116.1
  M. P. 130.5°C
  B. P. 135°C Decomposes
  Density 1.590 @20°/4°C
  Vap. D. 4.0
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

MALEIC ANHYDRIDE

Synonym: Toxilic anhydride; cis-butene dioic anhydride.
Description: Fused block or white crystals.
Formula:

$\underbracket{OCOCHCHCO}$

Constants:
  Mol. Wt. 98.1
  M. P. 58°C
  B. P. 202°C
  Flash P. 218°F (C.C.)
  Density 0.934 @20°/4°C
  Autoign. Temp. 890°F
  Vap. Press. 1 mm @44.0°C
  Vap. D. 3.4

Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; will react with water or steam to produce heat; emits toxic fumes when heated; can react on contact with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

MALT EXTRACT

Description: A powder.
Composition: Contains diastase, dextrin, dextrose, protein bodies and barley salts.
Toxic Hazard Rating:
  Acute Local: Allergen 1; Inhalation 1
  Acute Systemic: Inhalation 1
  Chronic Local: Allergen 1
  Chronic Systemic: U
Toxicology: Malt has been associated with grain or malt fever, an illness existing among grain workers. This is described in the literature as follows. It occurs several hours after the patient leaves work, possibly during sleep. It causes headache, weakness, fever, chills and cold sweats, as well as nausea, coughing, and often vomiting. By morning these symptoms have subsided. The victim feels normal and generally reports back for work. This strange illness occurs most frequently among men never before exposed to grain dust, or even among experienced men at the beginning of a new season or upon returning to work after a short absence. It resembles metal fume fever because only those constantly exposed appear to develop an immunity. No really satisfactory explanation can be offered for this reaction to malt dust, except that it is probably due to the presence of a foreign protein.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Slight, in the form of dust, when exposed to flame.
Storage and Handling: Section 7

MANGANESE

Description: Reddish-gray or silvery, brittle, metallic element.
Formula: Mn
Constants:
  At. Wt. 54.93
  M. P. 1260°C
  B. P. 1900°C
  Density 7.20
  Vap. Press. 1 mm @1292°C
Toxic Hazard Rating:
  Acute Local: 0
  Acute Systemic: Inhalation 2
  Chronic Local: U
  Chronic Systemic: Inhalation 3
MAC: ACGIH (accepted); 3 parts per million in air; 6 milligrams per cubic meter of air.
Radiation Hazard (Section 5): Artificial isotope Mn^{52}, half-life: 6 days; emits gamma rays of 0.73; 0.94 and 1.5 mev and positron particles of 0.58 mev. Hazard Rating, Class I (National Bureau of Standards Handbook No. 42).

Artificial isotope Mn^{54}, half-life: 310 days; emits gamma rays of 0.84 mev.

Artificial isotope Mo^{99}, half-life: 68 hours; emits beta particles of 0.2 and 1.2 mev and gamma rays of 0.75 mev. The permissible levels are: In body: 50 microcuries; in air: 2×10^{-3} microcurie per milliliter; in water: 14 microcurie per milliliter.

Artificial isotope Pm^{147}, half-life: 3.9 years; emits beta particles of 0.23 mev. The permissible levels are: In body: 120 microcuries; in air; 2×10^{-7} microcurie per milliliter; in water: 1 microcure per milliliter.

Artificial isotope Tb^{160}, half-life: 76 days; emits beta particles of 0.72 mev; the energy of gamma rays is doubtful.
Fire Hazard: Moderate, in the form of dust or powder, when exposed to flame.
Spontaneous Heating: No

To Fight Fire: Special mixtures of dry chemical (Section 6).
Explosion Hazard: Moderate, in the form of dust, when exposed to flame. See also Powdered Metals.
Disaster Control: Moderately dangerous; will react with water or steam to produce hydrogen; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

MANGANESE ARSENATE

Description: Reddish-white, crystalline solid.
Formula: $MnHAsO_4$
Constant:
Mol. Wt. 194.9
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

MANGANESE BENZOATE. See Manganous Benzoate.

MANGANESE BROMIDE. See Manganese Dibromide.

MANGANESE CACODYLATE

Description: Reddish-white crystals.
Formula: $Mn[(CH_3)_2AsO_2]_2$
Constant:
Mol. Wt. 328.9
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

MANGANESE CHLORIDE. See Manganese Dichloride.

MANGANESE COMPOUNDS

Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3

Toxicology: Chronic manganese poisoning is a clearly characterized disease which results from the inhalation of fumes or dusts of manganese. Exposure to heavy concentrations of dusts or fumes for as little as three months may produce the condition, but usually cases develop after one to three years of exposure. The central nervous system is the chief site of damage. If cases are removed from exposure shortly after the appearance of symptoms, some improvement in the patient's condition frequently occurs, though there may be some residual disturbances in gait and speech. When well established, however, the disease results in permanent disability.

Individuals exposed to dusts and fumes of manganese have been reported by several investigators to suffer from a much higher incidence of upper respiratory infections and pneumonia than does the general population. It has not yet been possible to prove that a definite pneumonitis results in humans from exposure to manganese dusts or fumes under industrial conditions. However, experiments with mice have produced definite and striking lung pathology which varied in intensity with the length of exposure to the dust.

Chronic manganese poisoning begins usually with complaints of languor and sleepiness. This is followed by weakness in the legs and the development of a stolid, mask-like facies, and the patient speaks with a slow monotonous voice. Then muscular twitchings appear, varying from a fine tremor of the hands to coarse, rhythmical movements of the arms, legs and trunk. Nocturnal cramps of the legs appear about the same time. There is a slight increase in tendon reflexes, ankle and patellar clonus, and a typical Parkinsonian slapping gait. The handwriting may be quite minute. There are no sensory disturbances, and no eye, gastrointestinal or genitourinary complaints. The urine and spinal fluid are normal, and the blood shows no abnormality or only a slight leucopenia. The symptoms may simulate progressive bulbar paralysis, postencephalitic Parkinsonism,

multiple sclerosis, amyotrophic lateral sclerosis and progressive lenticular degeneration (Wilson's disease). Often, a history of exposure is the only aid in establishing the diagnosis.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

MANGANESE DIBROMIDE
Synonym: Manganese bromide.
Description: Rose-red crystals.
Formula: $MnBr_2 \cdot 4H_2O$
Constants:
  Mol. Wt. 286.8
  M. P. 64°C (decomp.)
  Density 4.385 @25°C
Toxicity: See Manganese Compounds.
Disaster Control: See Bromides.
Storage and Handling: Section 7

MANGANESE DICHLORIDE
Synonyms: Scacchite; manganese chloride.
Description: Cubic, deliquescent, pink crystals.
Formula: $MnCl_2$
Constants:
  Mol. Wt. 125.84
  M. P. 650°C
  B. P. 1190°C
  Density 2.977 @25°C
Toxicity: See Manganese Compounds.
Storage and Handling: Section 7

MANGANESE DIFLUORIDE
Synonym: Manganese fluoride.
Description: Red, tetragonal crystals or reddish powder.
Formula: MnF_2
Constants:
  Mol. Wt. 92.93
  M. P. 856°C
  Density 3.98
Toxicity: See Fluorides and Manganese Compounds.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

MANGANESE DIIODIDE
Synonym: Manganese iodide.
Description: Yellowish-brown or pink, deliquescent crystalline mass or white powder.
Formula: $MnI_2 \cdot 4H_2O$
Constants:
  Mol. Wt. 380.8
  M. P. Decomp. @approx. 80°C
  Density 5.01
Toxicity: See Manganese Compounds.
Disaster Control: See Iodides.
Storage and Handling: Section 7

MANGANESE DIOXIDE
Synonym: Manganese oxide.
Description: Black powder.
Formula: MnO_2
Constants: Mol. Wt. 86.93
  M. P. −O @535°C
  Density 5.0
Toxicity: See Manganese Compounds.
Fire Hazard: Moderate, by chemical reaction; a powerful oxidizer. It must not be heated or rubbed in contact with easily oxidizable matter (Section 6).
Disaster Control: Moderately dangerous; keep away from heat and flammable materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  Coast Guard Classification: Hazardous material.

MANGANESE HEPTOXIDE
Description: A dark red oil.
Formula: Mn_2O_7
Constants:
  Mol. Wt. 221.9
  M. P. < -20°C
  B. P. Explodes @70°C
  Density > 1.84
Toxicity: See Manganese Compounds.
Fire Hazard: Dangerous, by chemical reaction; a powerful oxidizer (Section 6).
Explosion Hazard: Severe, when shocked or exposed to heat.
Explosive Range: @70°C.
Disaster Control: Highly dangerous; shock or heat will explode it; can react vigorously with reducing materials.
Storage and Handling: Section 7

MANGANESE HYPOPHOSPHITE
Description: Pink, odorless crystals.
Formula: $Mn(H_2PO_2)_2 \cdot H_2O$
Constant: Mol. Wt. 202.9
  M. P. $-H_2O > 150$°C
Toxicity: See Manganese Compounds.
Fire Hazard: See Hypophosphites.

Explosion Hazard: See Hypophosphites.
Disaster Control: See Hypophosphites.
Storage and Handling: Section 7

MANGANESE IODIDE. See Manganese Diiodide.

MANGANESE IODOPLATINATE
Description: Crystals.
Formula: $MnPtI_6 \cdot 9H_2O$
Constants:
Mol. Wt. 1173.82
M. P. Decomposes
Density 3.60
Toxicity: See Platinum Compounds and Manganese Compounds.
Disaster Control: See Iodides.
Storage and Handling: Section 7

MANGANESE LEAD RESINATE
Description: Dark brown to black mass.
Toxicity: See Lead Compounds and Manganese Compounds.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated, it emits highly toxic fumes of lead; can react with oxidizing materials.
Storage and Handling: Section 7

MANGANESE MONOARSENIDE
Description: Black, hexagonal crystals.
Formula: MnAs
Constants:
Mol. Wt. 129.84
M. P. Decomp. @400°C
Density 6.2
Toxicity: Highly toxic. See Arsenic Compounds.
Fire Hazard: Moderate, when exposed to flame. It will react with water and acids to form hydrogen arsenide (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of arsenic; will react with water, steam or acids to produce toxic and flammable vapors; can react with oxidizing materials.
Storage and Handling: Section 7

MANGANESE MONOBORIDE
Description: Crystalline powder.
Formula: MnB
Constants:
Mol. Wt. 65.75
Density 6.2 @15°C
Toxicity: See Manganese Compounds and Boron Compounds.
Fire Hazard: Moderate; will react with acids or steam to form boron hydride. It will ignite in presence of powerful oxidizers (Section 6).
Explosion Hazard: Moderate, by chemical reaction. See Boron Hydride.
Disaster Control: Dangerous; will react with water, steam or acids to produce toxic and flammable vapors; it reacts vigorously with oxidizing materials.
Storage and Handling: Section 7

MANGANESE MONOPHOSPHIDE
Description: Dark gray crystals.
Formula: MnP
Constants: Mol. Wt. 85.91
M. P. 1190°C
Density 5.39 @21°C
Toxicity: See Phosphides and Manganese Compounds.
Fire Hazard: Dangerous, when exposed to flame or by chemical reaction (Section 6).
Explosion Hazard: Moderate, by chemical reaction with moisture or acids.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus; will react with water, steam or acids to produce toxic and flammable vapors; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

MANGANESE OXALATE. See Manganous Oxalate.

MANGANESE PYROPHOSPHATE See Manganous Pyrophosphate.

MANGANESE RESINATE
Description: Dark, brownish-black mass.
Formula: $Mn(C_{20}H_{29}O_2)_2$
Constant:
Mol. Wt. 657.8
Toxicity: See Manganese Compounds.

Fire Hazard: Slight, when exposed to heat or flame or by reaction with powerful oxidizers (Section 6).
Storage and Handling: Section 7

MANGANESE SELENATE
Description: Rhombic crystals.
Formula: $MnSeO_4 \cdot 2H_2O$
Constants:
Mol. Wt. 233.92
Density 2.95 - 3.01
Toxicity: See Manganese Compounds and Selenium Compounds.
Disaster Control: See Selenium Compounds.

MANGANESE SELENIDE
Description: Gray, cubic crystals.
Formula: MnSe
Constants:
Mol. Wt. 133.89
Density 5.59 @15°C
Toxicity: See Manganese Compounds and Selenium Compounds.
Fire Hazard: Moderate, by chemical reaction either with moisture or acids to liberate selenium hydride, or on contact with powerful oxidizers (Section 6).
Explosion Hazard: Moderate, by chemical reaction.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of selenium; will react with water or acids to produce toxic and flammable vapors; can react with oxidizing materials.

MANGANESE SELENITE. See Manganous Selenite.

MANGANESE SULFATE. See Manganous Sulfate.

MANGANESE TARTRATE. See Manganous Tartrate.

MANGANIC FLUORIDE
Description: Red crystals.
Formula: MnF_3
Constants:
Mol. Wt. 111.93
M. P. Decomposes
Density 3.54
Toxicity: See Manganese Compounds and Fluorides.
Disaster Control: See Fluorides.

MANGANIC m-PHOSPHATE
Description: Pink crystals.
Formula: $Mn_2(PO_3)_6 \cdot 2H_2O$
Constant:
Mol. Wt. 619.8
Toxicity: See Manganese Compounds.
Storage and Handling: Section 7

MANGANIC o-PHOSPHATE
Description: Greenish-gray crystalline powder.
Formula: $MnPO_4 \cdot H_2O$
Constant:
Mol. Wt. 167.93
Toxicity: See Manganese Compounds.
Storage and Handling: Section 7

MANGANIC SULFATE
Description: Green, deliquescent crystals.
Formula: $Mn_2(SO_4)_3$
Constants:
Mol. Wt. 398.06
M. P. Decomposes @160°C
Toxicity: See Manganese Compounds.

MANGANOCYANIC ACID
Formula: $H_4Mn(CN)_6$
Constants:
Mol. Wt. 215.07
M. P. Decomposes
Toxicity: Highly toxic. See Cyanides.
Storage and Handling: Section 7

MANGANOUS ARSENATE. See Manganese Arsenate.

MANGANOUS BENZOATE
Synonym: Manganese Benzoate.
Description: Flat prisms.
Formula: $Mn(C_7H_5O_2)_2 \cdot 3H_2O$
Constant:
Mol. Wt. 351.20
Toxicity: See Manganese Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

MANGANOUS CHLOROPLATINATE
Description: Crystals.
Formula: $MnPtCl_6 \cdot 6H_2O$
Constants:
Mol. Wt. 571.00
M. P. Decomposes
Density 2.692
Toxicity: See Platinum Compounds and Manganese Compounds.
Disaster Control: See Chlorides.
Storage and Handling: Section 7

MANGANOUS CITRATE
Description: White-reddish powder.
Formula: $Mn_3(C_6H_5O_7)_2$
Constant:
Mol. Wt. 542.99
Toxicity: See Manganese Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

MANGANOUS FERROCYANIDE
Description: Greenish-white powder.
Formula: $Mn_2Fe(CN)_6 \cdot 7H_2O$
Constant:
Mol. Wt. 447.93
Toxicity: See Manganese Compounds.
Disaster Control: See Ferrocyanides.
Storage and Handling: Section 7

MANGANOUS FLUOGALLATE
Description: Pink crystals.
Formula: $[Mn(H_2O)_6][GaF_5 \cdot H_2O]$
Constants:
Mol. Wt. 345.76
M. P. Decomposes @230°C
Density 2.22
Toxicity: See Fluogallates and Manganese Compounds.
Disaster Control: See Fluogallates.
Storage and Handling: Section 7

MANGANOUS FLUOSILICATE
Synonym: Manganous silicofluoride.
Description: Hexagonal, rose-red prisms.
Formula: $MnSiF_6 \cdot 6H_2O$
Constants:
Mol. Wt. 305.09
M. P. Decomposes
Density 1.903
Toxicity: See Fluosilicates and Manganese Compounds.
Disaster Control: See Fluosilicates.
Storage and Handling: Section 7

MANGANOUS FORMATE
Description: Rhombic crystals.
Formula: $Mn(CHO_2)_2 \cdot 2H_2O$
Constants:
Mol. Wt. 181.00
M. P. Decomposes
Density 1.953
Toxicity: See Manganese Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

MANGANOUS HYDROXIDE
Synonym: Pyrochroite.
Description: White-pink crystals.
Formula: $Mn(OH)_2$
Constants:
Mol. Wt. 88.95
M. P. Decomposes
Density 3.258 @13°C
Toxicity: See Manganese Compounds.

MANGANOUS NITRATE
Description: Monoclinic rose-white or colorless crystals.
Formula: $Mn(NO_3)_2 \cdot 6H_2O$
Constants:
Mol. Wt. 287.04
M. P. 25.8°C
B. P. 129.4°C
Density 1.82
Toxicity: See Manganese Compounds and Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

MANGANOUS OXALATE
Synonym: Manganese oxalate.
Description: White crystals or powder.
Formula: $MnC_2O_4 \cdot 2H_2O$
Constants:
Mol. Wt. 179.0
M. P. $-2H_2O$ @100°C
Density 2.43 @21.7°C
Toxicity: See Oxalates and Manganese Compounds.
Fire Hazard: Slight; when heated, it emits toxic fumes (Section 6).
Storage and Handling: Section 7

MANGANOUS o-PHOSPHATE
Description: Rhombic crystals or pale rose-pink or yellowish-white granules.
Formula: $Mn_3(PO_4)_2 \cdot 3H_2O$
Constants:
Mol. Wt. 408.80
Density 3.102
Toxicity: See Manganese Compounds.

MANGANOUS PYROPHOSPHATE
Synonym: Manganese pyrophosphate.
Description: Monoclinic, brown-pink crystals.
Formula: $Mn_2P_2O_7$
Constants:
Mol. Wt. 283.82
M. P. 1196°C
Density 3.707 @25°C
Toxicity: See Manganese Compounds.

MANGANOUS SELENITE
Synonym: Manganese selenite.
Description: Crystals.
Formula: $MnSeO_3 \cdot 2H_2O$
Constant: Mol. Wt. 217.92
Toxicity: Highly toxic. See Manganese Compounds and Selenium Compounds.
Disaster Control: See Selenium Compounds.

MANGANOUS SULFATE
Synonym: Manganese sulfate.
Description: Reddish crystals.
Formula: $MnSO_4$
Constants: Mol. Wt. 151.00
M. P. 700°C
B. P. Decomposes @850°C
Density 3.25
Toxicity: See Manganese Compounds.

MANGANOUS SULFIDE
Synonym: Alabandite.
Description: Cubic, green, amorphous crystals.
Formula: MnS
Constants:
Mol. Wt. 87.00
M. P. Decomposes
Density 3.99
Toxicity: See Manganese Compounds.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

MANGANOUS TARTRATE
Synonym: Manganese tartrate.
Description: White powder.
Formula: $MnC_4H_4O_6$
Constant:
Mol. Wt. 203.00
Toxicity: See Manganese Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

MANGANOUS THIOCYANATE
Description: Deliquescent crystals.
Formula: $Mn(SCN)_2 \cdot 3H_2O$
Constants: Mol. Wt. 225.15
M. P. $-3H_2O$ @160°C to 170°C
Toxicity: See Manganese Compounds.
Disaster Control: See Thiocyanates.
Storage and Handling: Section 7

MANNITOL HEXANITRATE
Synonym: Mannitol nitrate.
Description: Colorless crystals.
Formula: $C_6H_8(NO_3)_6$
Constants:
Mol. Wt. 452.17
M. P. 112°C
B. P. Explodes @120°C
Density 1.603 @0°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
Fire Hazard: See Nitrates.
Explosion Hazard: Severe, when shocked or exposed to heat. A very sensitive high explosive used as a substitute for fulminates and in combination with tetracine. See also Explosives, High and Nitrates.
Disaster Control: Highly dangerous! See Nitrates and Explosives, High.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

MANNITOL MONOLAURATE
Description: Colorless solid.
Formula: $C_6H_8(OH)_5CO_2C_{11}H_{23}$
Constant:
Mol. Wt. 364.5
Toxicity: Details unknown; a fly spray.
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials.
Storage and Handling: Section 7

MATCHES
Composition: Usually contain phosphorus, antimony and sulfur.
Toxicity: Details unknown. See individual components.
Fire Hazard: Dangerous, when exposed to heat or flame or by spontaneous chemical reaction. Keep away from rodents!
Disaster Control: Dangerous; will tend to propagate fires; emit toxic fumes of phosphorus, sulfur and antimony.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable solid; yellow label.

- Coast Guard Classification: Inflammable solid.

MAUVINE HYDROBROMIDE

Description: Yellowish powder.
Toxic Hazard Rating:
- Acute Local: U
- Acute Systemic: Ingestion 3; Inhalation 3
- Chronic Local: U
- Chronic Systemic: U

Disaster Control: Dangerous; when heated, it emits highly toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

MCABEES. See Explosives, High.

MELAMINE

Synonym: 2,4,6-Triamino-s-triazine.
Description: Monoclinic colorless prisms.
Formula:
- $NC(NH_2)NC(NH_2)NC(NH_2)$

Constants:
- Mol. Wt. 126.13
- M. P. 250°C
- B. P. Sublimes
- Density 1.573 @20°/4°C
- Vap. Press. 50 mm @315°C
- Vap. D. 4.34

Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of cyanides.
Storage and Handling: Section 7

MENHADEN OIL

Synonyms: Pogy oil; moss bunker oil.
Description: Thick liquid derived from fish.
Constants:
- Autoign. Temp. 828°F
- Freezing P. −5°C
- Flash P. 435°F (C.C.)
- Density 0.923 - 0.933

Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: Yes
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

1(7),2-p-MENTHADIENE

Synonym: β-Phellandrene.
Description: Oily liquid; slight citrus odor.
Formula: $C_{10}H_{16}$
Constants:
- Mol. Wt. 136.2
- B. P. 171.2°C
- Flash P. 120°F (T.C.C.)
- Density 0.843 - 0.849 @75°C
- Vap. D. 4.68

Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

MENTHOL

Synonym: Hexahydrothymol.
Description: Crystals; peppermint taste and odor.
Formula: $C_{10}H_{19}OH$
Constants:
- Mol. Wt. 156.26
- M. P. 42.5°C
- B. P. 212.0°C
- Density 0.890 @15°/15°C
- Vap. Press. 1 mm @56.0°C
- Vap. D. 5.38

Toxic Hazard Rating:
- Acute Local: Irritant 2; Allergen 1; Ingestion 1; Inhalation 1
- Acute Systemic: U
- Chronic Local: Irritant 1; Allergen 1
- Chronic Systemic: U

Fire Hazard: Slight; when heated, it emits toxic fumes (Section 6).
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

MERCAPTANS

Toxic Hazard Rating:
- Acute Local: Irritant 3; Inhalation 3
- Acute Systemic: Inhalation 3
- Chronic Local: U
- Chronic Systemic: Inhalation 2

Toxicology: Mercaptans generally have a very offensive odor, which

may cause nausea and headache. High concentrations can produce unconsciousness with cyanosis, cold extremities and rapid pulse.
Disaster Control: Dangerous; when heated to decomposition, they almost always emit highly toxic fumes of oxides of sulfur; they will react with water, steam or acids to produce toxic and flammable vapors; they can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-MERCAPTOBENZOTHIAZOLE
Description: Light yellow powder.
Formula: $\underline{C_6H_4SCN}SH$
Constants:
Mol. Wt. 167.3
M. P. 170°C
Density 1.42 @25°C
Toxicity: Details unknown. See Mercaptans.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of sulfur compounds; can react with oxidizing materials.
Storage and Handling: Section 7

MERCAPTOETHANOL
Synonym: 2-Hydroxyethyl-mercaptan.
Description: Water-white, mobile liquid.
Formula: $HSCH_2CH_2OH$
Constants:
Mol. Wt. 78.13
B. P. 157.1°C
Flash P. 170°F (C.O.C.)
Density 1.1168 @20°/20°C
Vap. Press. 1.0 mm @20°C
Vap. D. 2.69
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical, carbon tetrachloride or water spray (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-MERCAPTOETHYLAMINE HYDROCHLORIDE
Description: White, slightly hygroscopic crystals.
Formula: $HSCH_2CH_2NH_2 \cdot HCl$
Constants:
Mol. Wt. 113.6
M. P. 70.2 - 70.7°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; will react with water or steam to produce toxic fumes.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

MERCURIC ACETATE
Description: White, crystalline powder.
Formula: $Hg(C_2H_3O_2)_2$
Constants:
Mol. Wt. 318.70
M. P. Decomposes
Density 3.270
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: See Mercury Compounds, Organic.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MERCURIC ACETYLIDE
Description: White powder.
Formula: $3HgC_2 \cdot H_2O$
Constants:
Mol. Wt. 691.91
M. P. Explodes
Density 5.3

Toxicity: Highly toxic. See Mercury Compounds, Organic.
Fire Hazard: Details unknown. See also Acetylides.
Explosion Hazard: Severe, when shocked or exposed to heat.
Disaster Control: Dangerous! Heat or shock will cause detonation; when heated, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURIC AMMONIUM CHLORIDE

Description: White, pulverulent lumps or powder.
Formula: $HgCl_2 2NH_4Cl \cdot 2H_2O$
Constant:
Mol. Wt. 414.5
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: See Mercury Compounds, Inorganic.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MERCURIC ARSENATE

Description: Yellow powder.
Formula: $HgHAsO_4$
Constants:
Mol. Wt. 340.5
M. P. Decomposes
Toxicity: Highly toxic. See Mercury Compounds, Inorganic and Arsenic Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of mercury and arsenic.
Storage and Handling: Section 7

MERCURIC o-ARSENATE

Description: Yellow crystals.
Formula: $Hg_3(AsO_4)_2$
Constant:
Mol. Wt. 879.65
Toxicity: Highly toxic. See Arsenic Compounds and Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of mercury and arsenic.
Storage and Handling: Section 7

MERCURIC BARIUM BROMIDE

Synonym: Barium-mercury bromide.
Description: Colorless, very hygroscopic crystals.
Formula: $HgBr_2 \cdot BaBr_2$
Constant:
Mol. Wt. 657.6
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURIC BARIUM IODIDE

Description: Reddish or yellow, unstable, deliquescent, crystalline mass.
Formula: $HgI_2 \cdot BaI_2 \cdot 5H_2O$
Constant:
Mol. Wt. 935.73
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURIC BENZOATE

Description: White crystalline powder.
Formula: $Hg(C_7H_5O_2)_2$
Constants:
Mol. Wt. 442.83
M. P. 165 °C
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MERCURIC BROMATE

Description: Crystals.
Formula: $Hg(BrO_3)_2 \cdot 2H_2O$
Constants:
Mol. Wt. 492.47
M. P. Decomp. @130 - 140 °C
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.

Fire Hazard: See Bromates.
Explosion Hazard: See Bromates.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of mercury; can react with reducing materials.
Storage and Handling: Section 7

MERCURIC BROMIDE

Description: Rhombic, colorless crystals.
Formula: $HgBr_2$
Constants:
- Mol. Wt. 360.44
- M. P. 237°C
- B. P. 319°C (sublimes)
- Density 6.109 @25°C
- Vap. Press. 1 mm @136.5°C

Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
- I.C.C. Classification: Poison B; poison label.
- Coast Guard Classification: Poison B; poison label.

MERCURIC BROMIDE, AMMONOBASIC

Description: White powder.
Formula: $Hg(NH_2)Br$
Constants:
- Mol. Wt. 296.55
- M. P. Decomposes

Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURIC BROMIDE DIAMMINE

Description: White powder.
Formula: $Hg(NH_3)_2Br_2$
Constants:
- Mol. Wt. 394.51
- M. P. 180°C

Toxicity: Highly toxic: See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURIC BROMIDE IODIDE

Description: Rhombic, yellow crystals.
Formula: HgBrI
Constants:
- Mol. Wt. 407.45
- M. P. 229°C
- B. P. 360°C

Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURIC CHLORATE

Description: Colorless, needle-like crystals.
Formula: $Hg(ClO_3)_2$
Constants:
- Mol. Wt. 367.52
- M. P. Decomposes
- Density 4.998

Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Fire Hazard: See Chlorates.
Explosion Hazard: See Chlorates.
Disaster Control: Dangerous; shock will explode it; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of mercury and chlorine; can react with reducing materials.
Storage and Handling: Section 7

MERCURIC CHLORIDE

Synonym: Corrosive sublimate.
Description: White crystals or powder.
Formula: $HgCl_2$
Constants:
- Mol. Wt. 271.52
- M. P. 277°C
- B. P. 304°C
- Density 5.440 @25°C
- Vap. Press. 1 mm @136.2°C

Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
- MCA warning label.

MERCURIC CHLORIDE DIAMMINE

Description: Fusible white precipitate.

Formula: $Hg(NH_3)_2Cl_2$
Constants:
Mol. Wt. 305.59
M. P. 300°C
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURIC CHLORIDE IODIDE

Description: Rhombic, red crystals.
Formula: HgClI
Constants:
Mol. Wt. 362.99
M. P. 153°C
B. P. 315°C
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURIC CHLOROIODIDE

Description: White crystals.
Formula: $2HgCl_2 \cdot HgI_2$
Constant:
Mol. Wt. 997.48
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURIC CHROMATE

Description: Rhombic, red crystals.
Formula: $HgCrO_4$
Constants:
Mol. Wt. 316.62
M. P. Decomposes
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Fire Hazard: Moderate, by chemical reaction; an oxidizer (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury; can react with reducing materials.
Storage and Handling: Section 7

MERCURIC CUPROUS IODIDE

Synonym: Copper-mercury iodide.
Description: Dark red, crystalline powder.
Formula: $HgI_2 \cdot 2CuI$
Constant:
Mol. Wt. 835.42
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURIC CYANIDE

Description: Colorless, transparent prisms, darkened by light.
Formula: $Hg(CN)_2$
Constants:
Mol. Wt. 252:65
M. P. Decomposes
Density 3.996
Toxicity: Highly toxic. See Cyanides and Mercury Compounds, Organic.
Fire Hazard: See Cyanides.
Explosion Hazard: See Cyanides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides and mercury; will react with water or steam to produce toxic fumes.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MERCURIC FLUORIDE

Description: Transparent crystals.
Formula: HgF_2
Constants:
Mol. Wt. 238.61
M. P. 645°C Decomposes
B. P. 650°C
Density 8.95 @15°C
Toxicity: Highly toxic. See Fluorides and Mercury Compounds, Inorganic.
Disaster Control: See Fluorides and Mercury Compounds, Inorganic.
Storage and Handling: Section 7

MERCURIC FLUOSILICATE

Description: Colorless, deliquescent crystals.
Formula: $HgSiF_6 \cdot 6H_2O$
Constant:
Mol. Wt. 450.77
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.

Disaster Control: See Mercury Compounds, Inorganic.
Storage and Handling: Section 7

MERCURIC IODATE

Description: Amorphous, white powder.
Formula: $Hg(IO_3)_2$
Constant:
Mol. Wt. 550.45
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Fire Hazard: See Iodates.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury; can react with reducing materials.
Storage and Handling: Section 7

MERCURIC IODIDE

Description: (1) Rhombic, yellow crystals; (2) Tetragonal red crystals or powder.
Formula: HgI_2
Constants:
Mol. Wt. 454.45
Density (1) 6.271; (2) 6.283
M. P. (1) 259°C; (2) Tr. 126-127°C
B. P. 354°C (sublimes)
Vap. Press. (1) 1 mm @157.5°C
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MERCURIC IODIDE AMMONOBASIC

Description: Dirty white crystals.
Formula: $Hg(NH_2)I$
Constant:
Mol. Wt. 343.55
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURIC IODIDE, AQUOBASIC-AMMONOBASIC

Description: Yellow to brown crystals.
Formula: OHg_2NH_2I
Constants:
Mol. Wt. 560.16
M. P. > 128°C
B. P. Explodes
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Explosion Hazard: Moderate, when exposed to heat.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury and may explode.
Storage and Handling: Section 7

MERCURIC IODIDE DIAMMINE

Description: Colorless or pale yellow powder or needles.
Formula: $Hg(NH_3)_2I_2$
Constant:
Mol. Wt. 488.51
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURIC IODIDE SOLUTION.

See Mercuric Iodide.
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MERCURIC LACTATE

Description: White, crystalline powder.
Formula: $Hg(C_3H_5O_3)_2$
Constant:
Mol. Wt. 378.71
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: See Mercury.
Storage and Handling: Section 7

MERCURIC NITRATE

Description: White-yellowish, deliquescent powder.
Formula: $Hg(NO_3)_2 \cdot \frac{1}{2}H_2O$
Constants:
Mol. Wt. 333.63
M. P. 79°C
B. P. Decomposes
Density 4.39
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.

Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

MERCURIC OLEATE
Synonym: Mercury oleate.
Description: Yellowish to red liquid; semi-solid or solid mass.
Formula: $(C_{17}H_{33}CO_2)_2Hg$
Constant:
Mol. Wt. 763.1
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: See Mercury.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MERCURIC OXALATE
Description: White powder.
Formula: HgC_2O_4
Constants:
Mol. Wt. 288.63
M. P. Decomposes
Toxicity: Highly toxic. See Mercury Compounds, Organic and Oxalates.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURIC OXIDE, RED
Description: Heavy, bright orange-red powder.
Formula: HgO
Constants:
Mol. Wt. 216.61
M. P. Decomposes @500°C
Density 11.14
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Fire Hazard: Slight, by chemical reaction; an oxidizer (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury; can react with reducing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MERCURIC OXIDE, YELLOW
Description: Light, odorless, amorphous, orange-yellow powder.
Formula: HgO
Constants:
Mol. Wt. 216.61
M. P. Decomposes @500°C
Density 11.14
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Fire Hazard: Slight, by chemical reaction; an oxidizer (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury; can react with reducing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MERCURIC OXYBROMIDE
Description: Yellow crystals.
Formula: $HgBr_2 \cdot 3HgO$
Constant:
Mol. Wt. 1010.27
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURIC OXYCHLORIDE
Description: Hexagonal, yellow crystals.
Formula: $HgCl_2 \cdot 3HgO$
Constants:
Mol. Wt. 921.35
M. P. Decomposes @260°C
Density 7.93
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURIC OXYCYANIDE
Description: White, crystalline powder or needles.
Formula: $Hg(CN)_2 \cdot HgO$
Constants:
Mol. Wt. 469.26
M. P. Explodes
Density 4.437 @19°C
Toxicity: Highly toxic. See Cyanides and Mercury Compounds, Organic.
Explosion Hazard: Severe, when

shocked or exposed to heat or flame.
Disaster Control: Dangerous; shock and heat will explode it; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides and mercury.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MERCURIC OXYFLUORIDE
Description: Yellow crystals.
Formula: $HgF_2 \cdot HgO \cdot H_2O$
Constants:
Mol. Wt. 473.24
M. P. Decomposes @100°C
Toxicity: Highly toxic. See Fluorides and Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of fluorides and mercury.
Storage and Handling: Section 7

MERCURIC OXYIODIDE
Description: Yellow-brown crystals.
Formula: $HgI_2 \cdot 3HgO$
Constant:
Mol. Wt. 1104.28
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURIC PERCHLORATE
Description: Colorless, deliquescent crystals.
Formula: $Hg(ClO_4)_2 \cdot 6H_2O$
Constant:
Mol. Wt. 507.62
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Fire Hazard: See Perchlorates.
Explosion Hazard: See Perchlorates.
Disaster Control: Dangerous; shock or heat will explode it; when heated, it emits highly toxic fumes of mercury; can react vigorously with reducing materials.
Storage and Handling: Section 7

MERCURIC PHENYL CYANAMIDE
Description: Powder.
Formula: $C_6H_5HgNCNH$
Constant:
Mol. Wt. 318.8
Toxicity: Highly toxic. See Mercury Compounds, Organic and Cyanides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides and mercury.
Storage and Handling: Section 7

MERCURIC PHOSPHATE
Synonym: Mercuric o-phosphate.
Description: Heavy white or yellowish powder.
Formula: $Hg_3(PO_4)_2$
Constant:
Mol. Wt. 791.87
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURIC o-PHOSPHATE. See Mercuric Phosphate.

MERCURIC POTASSIUM CYANIDE
Description: Colorless crystals.
Formula: $Hg(CN)_2 \cdot 2KCN$
Constant:
Mol. Wt. 382.85
Toxicity: Highly toxic. See Cyanides and Mercury Compounds, Organic.
Fire Hazard: See Cyanides.
Explosion Hazard: See Cyanides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides and mercury; will react with water or steam to produce toxic and flammable vapors.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MERCURIC POTASSIUM IODIDE

Description: Heavy, bright orange-red to yellow powder.
Formula: $HgI_2 \cdot 2KI$
Constant:
Mol. Wt. 786.5
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MERCURIC POTASSIUM THIOSULFATE

Description: White powder.
Formula: $HgS_2O_3 \cdot K_2S_2O_3$
Constant:
Mol. Wt. 503.1
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury and oxides of sulfur.
Storage and Handling: Section 7

MERCURIC SALICYLATE

Synonym: Mercury subsalicylate.
Description: White to yellowish powder.
Formula: $C_7H_4O_3Hg$
Constant:
Mol. Wt. 336.6
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MERCURIC SELENIDE

Synonym: Tiemannite.
Description: Gray plates.
Formula: HgSe
Constants:
Mol. Wt. 279.57
M. P. Sublimes
Density 7.1 - 8.9
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Fire Hazard: This material readily liberates hydrogen selenide upon contact with acids or moisture (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury; will react with water, steam or acids to produce toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

MERCURIC SESQUIIODIDE

Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURIC SILVER IODIDE

Description: Deep yellow powder.
Formula: $HgI_2 \cdot 2AgI$
Constant:
Mol. Wt. 924.1
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURIC STEARATE

Description: Yellowish, granular powder.
Formula: $(C_{18}H_{35}O_2)_2Hg$
Constant:
Mol. Wt. 767.5
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury; can react with oxidizing materials.
Storage and Handling: Section 7

MERCURIC SUBSULFATE

Description: Lemon yellow powder.
Formula: $HgSO_4 \cdot 2HgO$
Constants:
Mol. Wt. 729.90
B. P. Volatilizes
Density 6.44
Vap. D. 25.2
Toxicity: Highly toxic. See Mercury

Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.

MERCURIC SULFATE

Description: White, crystalline powder.
Formula: $HgSO_4$
Constants:
  Mol. Wt. 296.67
  M. P. Decomposes
  Density 6.47
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.

MERCURIC SULFIDE, BLACK

Synonym: Metacinnabarite.
Description: Black powder.
Formula: HgS
Constants:
  Mol. Wt. 232.67
  M. P. 583.5°C
  Density 7.73
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Fire Hazard: See Sulfides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury; will react with water, steam or acids to produce toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

MERCURIC SULFIDE, RED

Synonyms: Cinnabar; vermilion.
Description: Hexagonal, red crystals or powder.
Formula: HgS
Constants: Vap. D. 8.0
  Mol. Wt. 232.68
  M. P. Subl. @583.5°C
  Density 8.10
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Fire Hazard: See Sulfides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury; will react with water, steam or acids to produce toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

MERCURIC SULFOCYANATE

Synonyms: Mercury rhodanide; mercuric thiocyanate.
Description: White powder.
Formula: $Hg(SCN)_2$
Constants:
  Mol. Wt. 316.77
  M. P. Decomposes
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Fire Hazard: See Sulfides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of mercury; can react with oxidizing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.

MERCURIC TELLURATE

Description: Amber, cubic crystals.
Formula: Hg_3TeO_6
Constant:
  Mol. Wt. 825.44
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of mercury and tellurium.
Storage and Handling: Section 7

MERCURIC THALLIUM IODIDE

Description: Red, crystalline lumps.
Formula: $HgI_2 \cdot TlI$
Constant:
  Mol. Wt. 708.9
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition or on

contact with acid or acid fumes, it emits highly toxic fumes of mercury and thallium.
Storage and Handling: Section 7

MERCURIC THIOCYANATE. See Mercuric Sulfocyanate.

MERCURIC THYMOLATE
Description: Yellowish, gray powder; variable composition.
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURIC THYMOL NITRATE
Description: Amorphous, white to reddish-white powder.
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury; can react vigorously with reducing materials.
Storage and Handling: Section 7

MERCURIC THYMOLSALICYLATE
Description: White to reddish powder.
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury; can react with oxidizing materials.
Storage and Handling: Section 7

MERCURIC THYMOLSULFATE
Description: White to reddish-white powder.
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURIC TUNGSTATE
Description: Yellow crystals.
Formula: $HgWO_4$
Constants:
Mol. Wt. 448.53
M. P. Decomposes
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURICYANAMID
Description: A white solid.
Formula: $Hg(CN)_2$
Constant:
Mol. Wt. 252.65
Toxicity: Highly toxic. See Mercury Compounds, Organic and Cyanides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of cyanides and mercury; will react with water, steam or acids to produce toxic fumes.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MERCURIC ZINC ACETATE
Description: White crystals.
Formula:
$Hg(C_2H_3O_2)_2 + Zn(C_2H_3O_2)_2$
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

"MERCUROCHROME"
Synonym: Merbromin.
Formula: $C_{20}H_8Br_2HgNa_2O_6 \cdot 3H_2O$
Toxicity: Highly toxic if ingested. Relatively non-irritating and non-toxic to damaged skin or tissue. An antiseptic.

MERCUROL, SOLID
Description: Colorless to brownish powder.
Composition: Contains 20% mercury.
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury; can react with oxidizing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.

I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

"MERCUROSAL"

Synonym: Disodium hydroxy mercury salicyloxyacetate.
Description: White, amorphous powder.
Formula: $(HOHg)NaOOCC_6H_3OCH_2COONa$
Constant:
Mol. Wt. 456.69
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCUROUS ACETATE

Description: Colorless scales or plates.
Formula: $Hg_2(C_2H_3O_2)_2$
Constants:
Mol. Wt. 519.31
M. P. Decomposes
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCUROUS ARSENITE

Description: Unstable brown powder.
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of mercury and arsenic.
Storage and Handling: Section 7

MERCUROUS AZIDE

Description: White crystals.
Formula: $Hg_2(N_3)_2$
Constants:
Mol. Wt. 485.27
M. P. Explodes
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Explosion Hazard: Severe, when exposed to heat or flame, or even light. See also Azides.
Disaster Control: Dangerous; when heated, it emits highly toxic fumes of mercury, and may explode on exposure to heat.
Storage and Handling: Section 7

MERCUROUS BROMATE

Description: Crystals.
Formula: $Hg_2(BrO_3)_2$
Constants:
Mol. Wt. 657.06
M. P. Decomposes
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Fire Hazard: A powerful oxidizing agent. Keep away from flammable materials.
Explosion Hazard: See Bromates.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury; can react with reducing materials.
Storage and Handling: Section 7

MERCUROUS BROMIDE

Description: Tetragonal, white-yellow crystals.
Formula: Hg_2Br_2
Constants:
Mol. Wt. 561.07
M. P. Subl. @345°C
Density 7.307
Vap. D. 19.3
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MERCUROUS CARBONATE

Description: Yellow-brown crystals.
Formula: Hg_2CO_3
Constants:
Mol. Wt. 461.23
M. P. Decomp. @130°C
Density 5.07 @ 218°C
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCUROUS CHLORATE

Description: White crystals.

Formula: $HgClO_3$
Constants:
Mol. Wt. 284.1
M. P. Decomp. @250°C
Density 6.409
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Fire Hazard: See Chlorates.
Explosion Hazard: See Chlorates.
Disaster Control: Dangerous; shock and heat will explode it; when heated to decomposition, it emits highly toxic fumes of mercury; can react with reducing materials.
Storage and Handling: Section 7

MERCUROUS CHLORIDE
Synonym: Calomel.
Description: White, rhombic crystals or crystalline powder.
Formula: Hg_2Cl_2
Constants:
Mol. Wt. 472.14
M. P. Sublimes @400°C
Density 7.150
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCUROUS CHROMATE
Description: Red needles or powder.
Formula: Hg_2CrO_4
Constants:
Mol. Wt. 517.23
M. P. Decomposes
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Fire Hazard: Moderate by chemical reaction; an oxidizer (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury; can react with reducing materials.
Storage and Handling: Section 7

MERCUROUS FLUORIDE
Description: Cubic yellow crystals.
Formula: Hg_2F_2
Constants:
Mol. Wt. 439.22
M. P. 570°C
Density 8.73
Toxicity: Highly toxic. See Fluorides and Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of fluorides and mercury.
Storage and Handling: Section 7

MERCUROUS FLUOSILICATE
Description: Colorless prisms.
Formula: $Hg_2SiF_6 \cdot 2H_2O$
Constant:
Mol. Wt. 579.31
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCUROUS FORMATE
Description: Glistening scales.
Formula: $Hg_2(CHO_2)_2$
Constants:
Mol. Wt. 491.26
M. P. Decomposes
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCUROUS GLUCONATE
Description: White solid.
Formula: $HgCO_2C_5H_6(OH)_5$
Constant:
Mol. Wt. 395.8
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MERCUROUS IODATE
Description: Yellowish crystals.
Formula: $Hg_2(IO_3)_2$
Constants:
Mol. Wt. 751.06
M. P. Decomposes
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Fire Hazard: See Iodates.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury; can react with reducing materials.
Storage and Handling: Section 7

MERCUROUS IODIDE

Description: Yellow, tetragonal crystals or amorphous powder.
Formula: HgI
Constants:
Mol. Wt. 327.53
M. P. Subl. @140°C; decomp. @290°C
B. P. Decomp.
Density 7.70
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MERCUROUS MONO HYDROGEN o-ARSENATE

Description: Yellow-red crystals.
Formula: Hg_2HAsO_4
Constant:
Mol. Wt. 541.14
Toxicity: Highly toxic. See Arsenic Compounds and Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of arsenic and mercury.
Storage and Handling: Section 7

MERCUROUS NITRATE

Description: Short, colorless, prismatic crystals.
Formula: $Hg_2(NO_3)_2 \cdot 2H_2O$
Constants:
Mol. Wt. 561.26
M. P. 70°C
Density 4.79 @4°C
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Fire Hazard: See Nitrates.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury; can react vigorously with reducing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MERCUROUS NITRATE, AMMONIATED

Synonym: Black precipitate.
Description: Black powder.
Formula: $Hg_2ONH_2Hg_2NO_3$
Constant:
Mol. Wt. 896.48
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury; can react vigorously with reducing materials.
Storage and Handling: Section 7

MERCUROUS NITRITE

Description: Yellow crystals.
Formula: $Hg_2(NO_2)_2$
Constants:
Mol. Wt. 493.24
M. P. Decomp. @100°C
Density 7.33
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Fire Hazard: Moderate, by chemical reaction; an oxidizing agent (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury; can react with reducing materials.
Storage and Handling: Section 7

MERCUROUS OXALATE

Description: White crystals.
Formula: $Hg_2C_2O_4$
Constant:
Mol. Wt. 489.24
Toxicity: Highly toxic. See Oxalates and Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCUROUS OXIDE, BLACK

Description: Black to grayish-black powder.
Formula: Hg_2O
Constants:
Mol. Wt. 417.22
M. P. Decomp. @100°C
Density 9.8
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Fire Hazard: Moderate by chemical reaction; an oxidizer (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury; can react with reducing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MERCUROUS PHOSPHATE

Description: Heavy, white powder.
Formula: Hg_3PO_4
Constant:
Mol. Wt. 696.85
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCUROUS SULFATE

Description: White, crystalline powder.
Formula: Hg_2SO_4
Constants:
Mol. Wt. 497.28
M. P. Decomposes
B. P. Decomposes
Density 7.56
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MERCUROUS SULFIDE

Description: Black crystals.
Formula: Hg_2S
Constants:
Mol. Wt. 433.29
M. P. Decomposes @0°C
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Fire Hazard: See Sulfides.
Disaster Control: Dangerous when heated to decomposition, it emits highly toxic fumes of mercury and sulfides; will react with moisture or acids to produce toxic and flammable vapors; can react with oxidizing materials:
Storage and Handling: Section 7

MERCUROUS TARTRATE

Description: Yellowish-white crystalline powder.
Formula: $Hg_2C_4H_4O_6$
Constant:
Mol. Wt. 549.29
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURY

Description: Silvery liquid; metallic element.
Formula: Hg
Constants:
At. Wt. 200.61
M. P. −38.89°C
B. P. 356.9°C
Density 13.546
Vap. Press. 1 mm @126.2°C
Toxic Hazard Rating: (See also Mercury Compounds)
Acute Local: Allergen3; Ingestion 3
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: Irritant 1; Allergen 3
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
MAC: ACGIH (accepted); 0.01 part per million in air; 0.1 milligram per cubic meter of air.
Radiation Hazard: Artificial isotope Hg^{203}, half-life: 43.5 days; emits beta particles of 0.21 mev and gamma rays of 0.28 mev.
Disaster Control: Dangerous; when heated it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

MERCURY ACETAMIDE
Description: White powder.
Formula: CH_3CONHg
Constant:
Mol. Wt. 257.7
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURY ACETATE. See Mercurous Acetate or Mercuric Acetate.
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification; Poison B; poison label.

MERCURY, AMMONIATED
Synonyms: Ammonobasic mercuric chloride; white precipitate.
Description: White lumps or powder.
Formula: $HgNH_2Cl$
Constant:
Mol. Wt. 252.10
Toxicity: Highly toxic. See Mercury Compounds Inorganic.
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURY ANTIMONY SULFIDE
Description: Gray-black powder.
Composition: Mixture of equal parts of black mercury sulfide and gray antimony sulfide.
Toxicity: Highly toxic. See Mercury Compounds and Antimony.
Fire Hazard: See Sulfides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of mercury, antimony, and sulfides.
Storage and Handling: Section 7

MERCURY ATOXYLATE
Synonym: Mercury p-aminophenol arsenate.
Description: White powder.
Formula: $C_{12}H_{14}O_6N_2As_2Hg$
Constant:
Mol. Wt. 632.71
Toxicity: Highly toxic. See Arsenic Compounds and Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of arsenic and mercury.
Storage and Handling: Section 7

MERCURY BENZAMIDE
Description: White powder.
Formula: C_6H_5CONHg
Constant:
Mol. Wt. 319.7
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURY BICHLORIDE, SOLID
See Mercuric Chloride.
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MERCURY BISULFATE. See Mercuric Sulfate.
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MERCURY COLLOIDAL. See Mercury.

MERCURY COMPOUNDS, INORGANIC
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 2
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Irritant 2; Allergen 3
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Toxicology: Mercury is a general protoplasmic poison; after absorption it circulates in the blood and is stored in the liver, kidneys, spleen and bone. It is eliminated in the urine, feces, sweat, saliva and milk. In industrial poisoning,

the chief effect is upon the central nervous system and upon the mouth and gums. Colitis has been reported frequently; a nephritis or nephrosis is rarely reported. The organic mercury compounds, like the organic lead compounds, appear to have an affinity for the lipoid-containing organs, resulting in disturbances of the central nervous system resembling those of tetraethyl lead. Fulminate of mercury rarely produces symptoms of systemic poisoning, but frequently causes a dermatitis. Organic mercury compounds may act as vesicants on the skin (Section 9).

The cardinal symptoms of industrial mercury poisoning are stomatitis, tremors, and psychic disturbances. Usually the first complaints are of excessive salivation and pain on chewing; in severe cases there may be gingivitis, with loosening of the teeth, and a dark line on the gum margins, resembling the "lead line." In slow poisoning the salivation may be absent, and the only complaint dryness of the throat and mouth. Tremor and psychic disturbances are commonly seen in the slow, chronic form of the poisoning; the tremor is of the intention type, and may be seen when the patient spreads the outstretched fingers or protrudes the tongue, or attempts to perform specified movements. Muscles of the face, hands and arms are chiefly affected. In more severe cases there may also be convulsive or shaking movements; writing is frequently illegible. Hyperactive knee-jerks and scanning speech may be present in advanced cases. The psychic disturbance (so called "erethism") includes such changes as loss of memory, insomnia, lack of confidence, irritability, vague fears and depression.

With poisoning by organic mercury compounds the nervous system is usually affected. Tremor, ataxia, difficulty in speaking, and gross constriction of the visual fields are reported and there may be personality changes. In severe cases, psychoses can occur. The peripheral nerves and dorsal spinal roots may be affected, and the patient's condition resembles that of a dorsal root lesion.

The dermatitis produced by fulminate of mercury takes the form of small, discrete ulcers on the exposed parts, and is usually accompanied by conjunctivitis and inflammation of the mucous membranes of the nose and throat.

Elemental mercury is probably not absorbed through the gastrointestinal tract, but many mercury compounds are. A number of mercury compounds, in addition to the fulminate, can cause skin irritations and can be absorbed through the skin; they are strong allergens (Section 9).

Disaster Control: Dangerous; when heated to decomposition, they emit highly toxic fumes of mercury.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

MERCURY COMPOUNDS, N.O.S. SOLID.

See Mercury.

Shipping Regulations: Section 11.
  I. C. C. Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.

MERCURY COMPOUNDS, ORGANIC

Toxic Hazard Rating:
  Acute Local: Irritant 3; Allergen 2; Ingestion 3; Inhalation 2
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: Irritant 2; Allergen 3
  Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3

Toxicology: See Mercury Compounds, Inorganic.

MAC: ACGIH (tentative); 0.01 milligrams per cubic meter of air (as mercury).

Disaster Control: Dangerous; when heated to decomposition, they emit highly toxic fumes of mercury.

Ventilation Control (use high rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

MERCURY CYANIDE. See Mercuric Cyanide.
Shipping Regulations: Section 11.
  I.C.C Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.

MERCURY FULMINATE, MERCURIC FULMINATE. See Fulminate of Mercury, Dry.

MERCURY MORPHINE OLEATE

Description: An oleaginous mass.
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury; can react with oxidizing materials.
Storage and Handling: Section 7

MERCURY NAPHTHENATE

Description: A dark amber liquid.
Formula: $Hg(C_{10}H_7)_2$
Constants:
  Mol. Wt. 469.0
  Vap. D. 15.3
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Fire Hazard: Moderate; can react with oxidizing materials.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

MERCURY NITRIDE

Description: Brown powder.
Formula: Hg_3N_2
Constants:
  Mol. Wt. 629.85
  M. P. Explodes
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Explosion Hazard: Severe, when exposed to heat.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury and may explode.
Storage and Handling: Section 7

MERCURY NUCLEATE. See Mercurol, Solid.

MESITYL OXIDE

Synonym: 4-Methyl-3-penten-2-one.
Description: Oily, colorless liquid; strong odor.
Formula: $(CH_3)_2CCHCOCH_3$
Constants:
  Mol. Wt. 98.14
  M. P. -59°C
  B. P. 130.0°C
  Flash P. 90°F (C.C.)
  Density 0.8539 @20°/4°C
  Autoign. Temp. 652°F
  Vap. Press. 10 mm @26.0°C
  Vap. D. 3.38
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: Inhalation 3
MAC: ACGIH (accepted); 50 parts per million in air; 200 milligrams per cubic meter of air.
Toxicology: It can cause opaque cornea, keratoconus, and extensive necrosis of cornea. From animal experiments, it has been found that concentrations of 1,000 ppm for 4 hours at a time per day over an observation period of 14 days killed 3 out of 6 white mice, placing it in the category of moderate to definite toxic hazard. Guinea pigs and rats were subject to repeated inhalations of the vapors of this material. No effect upon them was found after the concentration had been reduced to 50 ppm, even with 30 eight-hour exposures. Single exposures tend to indicate that this ketone has greater acute and narcotic action than isophorone. It can have harmful effects upon the kidneys and liver, and may damage the eyes and lungs to a serious degree. Animals exposed to 100 ppm for 30 eight-hour exposures showed internal damage as noted above. Exposure to 500 ppm caused their death.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

METALDEHYDE

Synonyms: m-Acetaldehyde; polymerized acetaldehyde.
Description: Colorless crystals.
Formula: $(C_2H_4O)_4$
Constants:
- Mol. Wt. 176.21
- M. P. 475°F
- Flash P. 97°F (C.C.)
- Vap. D. 6.06

Toxicity: Details unknown. See also Aldehydes.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

METAL POLISH LIQUID

Constant:
- Flash P. < 80°F

Toxicity: Details unknown; some metals polishes can act as irritants and allergens.
Fire Hazard: Dangerous; when exposed to heat or flame; can react vigorously with oxidizing materials (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7

METANILIC ACID, SODIUM SALT.

See m-Aniline Sulfonic Acid.

METHACROLEIN

Synonym: a-Methylacrolein.
Description: Colorless liquid.
Formula: $CH_2C(CH_3)CHO$
Constants:
- Mol. Wt. 70.1
- B. P. 73.5°C
- Flash P. 5°F
- Density 0.830 @20°/4°C
- Vap. Press. 120 mm @20°C
- Vap. D. 2.42

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: Inhalation 3
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; on decomposition, it emits toxic fumes; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHACRYLIC ACID

Synonym: alpha-methylacrylic acid.
Description: Corrosive liquid or colorless crystals.
Formula: $(CH_3)(CH_2)CCOOH$
Constants:
- Mol. Wt. 86.1
- M. P. 15°C
- B. P. 161°C
- Flash P. 170°F (C.O.C.)
- Density 1.014 @25°C (glacial)
- Vap. Press. 1 mm @25.5°C

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

METHACRYLONITRILE

Synonym: 2-Methyl prophenitrile.
Description: Colorless liquid.
Formula: $H_2C = C(CH_3)C = N$

Constants:
Mol. Wt. 67.09
M. P. −40°C
B. P. 90.3°C
Density 0.805
Vap. Press. 40 mm @12.8°C
Toxicity: Highly toxic. See Cyanides.
Fire Hazard: See Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

1-METHALLYL ALCOHOL

Synonym: 2-Buten-1-ol.
Description: Colorless liquid.
Formula: $CH_3CHCHCH_2OH$
Constants:
Mol. Wt. 72.1
M. P. < −30°C
B. P. 118°C
Flash P. 94°F
Density 0.8726 @0°/4°C
Vap. D. 2.49
Toxicity: Details unknown; probably toxic. See also Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

METHALLYL CHLORIDE

Description: Colorless, volatile liquid; disagreeable odor.
Formula: C_4H_7Cl
Constants:
Mol. Wt. 90.55
B. P. 72.17°C
Freezing P. < −80°C
Flash P. 14°F (T.O.C.)
Density 0.9257 @20°/4°C
Vap. Press. 101.7 mm @20°C
Vap. D. 3.12
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: Irritant 1
Chronic Systemic: Ingestion 2; Inhalation 2
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 3.2 - 8.1% @75°F.
Disaster Control: Dangerous; on decomposition, it emits highly toxic fumes of chlorine; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHANE

Synonyms: Marsh gas; methyl hydride.
Description: Colorless, odorless, tasteless gas.
Formula: CH_4
Constants:
Mol. Wt. 16.04
B. P. −161.5°C
Freezing P. −183.2°C
Density 0.415 @−164°C; 0.7168 g/l
Autoign. Temp. 1000°F
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Inhalation 1
Chronic Local: 0
Chronic Systemic: Inhalation 1
Caution: A simple asphyxiant. See Argon for discussion of simple asphyxiants.
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide or dry chemical (Section 6).
Explosion Hazard: Dangerous, when exposed to heat or flame.
Explosive Range: 5.3 - 14.0%.
Disaster Control: Dangerous; due to shock, it can shatter the compressed gas container with explosive force.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable gas; red gas label.
Coast Guard Classification: Inflammable gas; red gas label.

METHANOL. See Methyl Alcohol.

3-METHOXY BUTANOL

Description: Liquid.
Formula: $CH_3CH(OCH_3)CH_2CH_2OH$

Constants:
- Mol. Wt. 104.15
- B. P. 161.1°C
- Freezing P. −85°C
- Flash P. 165°F (C.O.C.)
- Density 0.9229 @20°/20°C
- Vap. Press. 0.9 mm @20°C
- Vap. D. 3.59

Toxicity: Details unknown. See also Alcohols.

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

METHOXY BUTYL ACETATE

Synonym: Butoxyl.

Description: Liquid.

Formula: $CH_3CO_2C_4H_8OCH_3$

Constants:
- Mol. Wt. 146.2
- B. P. 275°F
- Flash P. 170°F
- Density 0.952-0.958 @20°/20°C
- Vap. D. 5.05

Toxicity: Details unknown. See Acetic Acid.

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

3-METHOXY BUTYL ALCOHOL.

See 3-Methoxy Butanol.

3-METHOXY BUTYRIC ACID

Description: Liquid.

Formula: $CH_3OC_3H_6COOH$

Constants: Mol. Wt. 118.13
- M. P. 12°C
- B. P. 139°C 50 mm
- Density 1.053 @20°/20°C

Toxicity: Unknown

Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials (Section 6).

Storage and Handling: Section 7

METHOXYCHLOR

Synonym: DMDT; 2,2-bis-(p-methoxyphenyl)-1,1,1-trichloroethane.

Description: Crystals.

Formula: $(CH_3OC_6H_4)_2CHCCl_3$

Constants:
- Mol. Wt. 345.7
- M. P. 78°C
- Vap. D. 12

Toxic Hazard Rating:
- Acute Local: Allergen 1
- Acute Systemic: Ingestion 1; Inhalation 1
- Chronic Local: Allergen 1
- Chronic Systemic: Ingestion 1; Inhalation 1

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.

Personal Hygiene: Section 3

Storage and Handling: Section 7

2-METHOXYETHANOL

Synonyms: Ethylene glycol methyl ether.

Description: Clear liquid.

Formula: $OCH_3CH_2CH_2OH$

Constants:
- Mol. Wt. 76.1
- M. P. −86.5°C
- B. P. 124.5°C
- Flash P. 125°F
- Density 0.9629 @25°/25°C
- Vap. Press. 10 mm @22.0°C
- Vap. D. 2.63

Toxic Hazard Rating:
- Acute Local: U
- Acute Systemic: Ingestion 2; Inhalation 2
- Chronic Local: U
- Chronic Systemic: Ingestion 2; Inhalation 2

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

2-(2-METHOXY ETHOXY) ETHANOL

Synonym: Diethylene glycol methyl ether.

Description: A clear, colorless liquid.

Formula: $CH_3OCH_2CH_2OCH_2CH_2OH$

Constants:
- Mol. Wt. 120.2
- B. P. 189 - 195°C

Flash P. 210°F
Density 1.0209 @20°/20°C
Vap. D. 4.14
Toxicity: Details unknown. See Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

METHOXY ETHYL ACETYL RICINOLEATE

Description: Light straw colored liquid.
Formula:
$C_{17}H_{32}(OOCCH_3)COOC_2H_4OCH_3$
Constants:
Mol. Wt. 398
M. P. −60°C (gels)
B. P. 200 - 260°C @4 mm
Flash P. 446°F
Density 0.966 @20°/20°C
Vap. Press. < 0.01 mm Hg @ 150°C
Vap. D. 13.8
Toxicity: Details unknown. See Esters.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

METHOXY ETHYL ACRYLATE

Description: Liquid.
Formula: $CH_2CHCO_2CH_2CH_2OCH_3$
Constants:
B. P. 61°C @17 mm
Flash P. 180°F (O. C.)
Density 1.0134 @20°C
Vap. D. 4.49
Toxicity: Details unknown. See Ethyl Acrylate.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

METHOXY ETHYL MERCURY CHLORIDE

Description: Crystals.
Formula: $OCH_3CH_2CH_2HgCl$
Constant:
Mol. Wt. 295.2
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury.
Storage and Handling: Section 7

METHOXY ETHYL OLEATE

Description: Light-colored liquid.
Formula:
$C_8H_{17}CHCH(CH_2)_7COOC_2H_4OCH_3$
Constants:
Mol. Wt. 340
M. P. −20°C
B. P. 188 - 225°C @4mm
Flash P. 386°F
Density 0.902 @20°/20°C
Vap. Press. 0.04 mm @150°C
Vap. D. 11.8
Toxicity: Details unknown. See Esters.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

METHOXY ETHYL PHTHALATE

Description: Liquid.
Formula: $(OCH_3CH_2CH_2CO_2)_2C_6H_4$
Constants:
Mol. Wt. 282.3
B. P. 190 - 220°C
Flash P. 275°F (C. C.)
Density 1.17
Vap. D. 9.75
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-METHOXY-4-NITROANILINE
Synonyms: 4-Nitro-o-anisidine; 5-nitro-2-aminoanisole; 1-amino-2-methoxy-4-nitrobenzene.
Description: Crystals.
Formula: $CH_3OC_6H_3NO_2NH_2$
Constant:
Mol. Wt. 168.2
Toxicity: Details unknown. See also Nitroaniline.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

2-METHOXY PHENOL
Synonym: Guaiacol.
Description: Light yellow liquid when melted.
Formula: $HOC_6H_4OCH_3$
Constants: Mol. Wt. 123.1
M. P. 28.3°C
B. P. 205.0°C
Density 1.12
Vap. Press. 1 mm @52.4°C
Toxicity: Details unknown. See Phenol and Cresote.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

1-METHOXY-2-PROPANOL. See Monopropylene Glycol Methyl Ether.

METHOXY PROPIONITRILE
Description: Liquid.
Formula: $OCH_3CH_2CH_2CN$
Constants:
Mol. Wt. 85.1
M. P. -63°C
B. P. 160°C
Flash P. 149°F
Density 0.92
Vap. D. 2.94
Toxicity: Highly toxic. See Cyanides.
Fire Hazard: Moderate, when exposed to heat or flame. See Cyanides.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of cyanides; will react with water, steam, or acids to produce toxic and flammable vapors; can react with oxidizing materials.
Storage and Handling: Section 7

3-METHOXYPROPYLAMINE
Description: Colorless liquid.
Formula: $CH_3OCH_2CH_2CH_2NH_2$
Constants:
Mol. Wt. 89.14
M. P. -75.7°C
B. P. 116°C
Flash P. 90°F (T.C.C.)
Density 0.8615 @30°C
Vap. Press. 20 mm @30°C
Vap. D. 3.07
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHOXYTRIGLYCOL ACETATE
Synonym: Triethylene glycol methyl ether acetate.
Description: Liquid.
Formula:
$CH_3O(CH_2)_2O(CH_2)_2O(CH_2)_2OCOCH_3$
Constants:
Mol. Wt. 206.23
B. P. 266°F
Flash P. 260°F (O.C.)
Density 1.094
Vap. D. 7.11
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

METHYL ABIETATE
Description: Liquid.
Formula: $CH_3C_{20}H_{29}O_2$

Constants:
  Mol. Wt. 316.5
  B. P. 680°F
  Flash P. 360 - 365°C
  Density 1.02
  Vap. D. 10.9
Toxicity: Probably similar to Abietic Acid.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

METHYL ACETATE

Description: Colorless, volatile liquid.
Formula: $CH_3CO_2CH_3$
Constants:
  Mol. Wt. 74.08
  M. P. −98.7°C
  B. P. 57.8°C
  Flash P. 14°F
  Density 0.92438
  Autoign. Temp. 935°F
  Vap. Press. 100 mm @9.4°C
  Vap. D. 2.55
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
  Chronic Local: U
  Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
MAC: ACGIH (accepted); 200 parts per million in air; 606 milligrams per cubic meter of air.
Toxicology: Methyl acetate is narcotic, but is less so than the higher members of the acetate series. It has an irritating effect upon the mucous membranes of the eyes and upper respiratory tract, and in this respect its action is stronger than that of the higher members of the series. The irritant concentration is about 10,000 ppm.

Signs and symptoms are irritation and burning of the eyes, lachrymation, dyspnea, palpitation of the heart, and complaints of depression or dizziness.
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
Underwriters Laboratory Classification: 85 - 90.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 4.1-13.9%
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Inflammable liquid; red label.

METHYL ACETOACETATE

Description: Colorless liquid.
Formula: $CH_3COCH_2COOCH_3$
Constants:
  Mol. Wt. 116.11
  M. P. 27.5°C
  B. P. 170°C
  Flash P. 180°F (C.C.)
  Density 1.077
  Vap. D. 4.00
Toxicity: Details unknown. Probably moderate.
Fire Hazard: Moderate, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

METHYL ACETONE

Description: Clear liquid.
Composition: A mixture of acetone, methyl acetate and methyl alcohol.
Constant:
  Flash P. 0°F (C.C.)
Toxicity: Probably toxic. See components, especially methyl alcohol.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown.

Disaster Control: Dangerous! Keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

METHYL ACETYLENE

Synonym: Propyne.
Description: Gas.
Formula: $H_3CC\equiv CH$
Constants:
Mol. Wt. 40.06
M. P. -101.5°C
B. P. -23.1°C
Density 0.674 @-23.1°C
Vap. Press. 3876 mm @20°C
Toxicity: Details unknown; has some anesthetic properties.
MAC: ACGIH (tentative); 1,000 parts per million in air.
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Moderate; when shocked, exposed to flame, or by spontaneous chemical reaction.
Disaster Control: Dangerous! May explode on shock or exposure to heat or open flame.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

METHYLACETYL RICINOLEATE

Description: Crystals.
Formula: $CH_3CH_2CH_2CO_2(CH_2)_7CHCHCH_2CHOH(CH_2)_5CH_3$
Constants:
Mol. Wt. 340.5
Vap. D. 11.9
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

α-METHYL ACROLEIN. See Methacrolein.

METHYL ACRYLATE

Description: Colorless liquid.
Formula: $CH_2CHCO_2CH_3$
Constants:
Mol. Wt. 86.1
B. P. 80°C
Freezing P. -75°C
Flash P. 27°F (O. C.)
Density 0.949 @25°C
Vap. Press. 100 mm @28°C
Vap. D. 2.97
Toxicity: Details unknown. Probably toxic. See Acrylic Acid.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYL ACRYLIC ACID. See Methacrylic Acid.

METHYLAL

Synonyms: Formal; methylene dimethyl ether; formaldehyde dimethylacetal.
Description: Colorless liquid; pungent odor.
Formula: $CH_2(OCH_3)_2$
Constants:
Mol. Wt. 76.1
M. P. -104.8°C
B. P. 42.3°C
Flash P. 0°F (O. C.)
Density 0.864 @20°/4°C
Vap. Press. 330 mm @20°C
Vap. D. 2.63
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Inhalation 2
Chronic Local: U
Chronic Systemic: Inhalation 1
MAC: ACGIH (accepted); 1000 parts per million in air; 3100 milligrams

per cubic meter of air.
Caution: High concentrations of vapors act as an anesthetic.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYL ALCOHOL

Synonyms: Methanol.
Description: Clear, colorless very mobile liquid.
Formula: CH_3OH
Constants:
  Mol. Wt. 32.04
  B. P. 64.8°C
  Freezing P. −97.8°C
  Flash P. 65°F (C.O.C.)
  Density 0.7913 @20°/4°C
  Autoign. Temp. 878°F
  Vap. Press. 100 mm @21.2°C
  Vap. D. 1.11
Toxic Hazard Rating:
  Acute Local: Irritant 1; Inhalation 1
  Acute Systemic: Ingestion 3; Inhalation 2; Skin Absorption 2
  Chronic Local: Irritant 1; Inhalation 1
  Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
MAC: ACGIH (accepted); 200 parts per million in air; 262 milligrams per cubic meter of air.
Toxicology: Methy alcohol possesses distinct narcotic properties. It is also a slight irritant to the mucous membranes. Its main toxic effect is exerted upon the nervous system, particularly the optic nerves and possibly the retinae. The effect upon the eyes has been attributed to optic neuritis, which subsides but is followed by atrophy of the optic nerve. Once absorbed, methyl alcohol is only very slowly eliminated. Coma resulting from massive exposures may last as long as 2 to 4 days. In the body the products formed by its oxidation are formaldehyde and formic acid, both of which are toxic. Because of the slowness with which it is eliminated, methyl alcohol should be regarded as a cumulative poison. Though single exposures to fumes may cause no harmful effect, daily exposure may result in the accumulation of sufficient methyl alcohol in the body to cause illness.

Severe exposures may cause dizziness, unconsciousness, sighing respiration, cardiac depression, and eventually death. Where the exposure is less severe, the first symptoms may be blurring of vision, photophobia and conjunctivitis, followed by the development of definite eye lesions. There may be headache, gastrointestinal disturbances, dizziness and a feeling of intoxication. The visual symptoms may clear temporarily, only to recur later and progress to actual blindness. Irritation of the mucous membranes of the throat and respiratory tract, peripheral neuritis, and occasionally, symptoms referable to other lesions of the nervous system have been reported. The skin may become dry and cracked due to the solvent action of methyl alcohol.
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical, or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 6.0 - 36.5%
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.

I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.
MCA warning label.

METHYL ALLYL CHLORIDE. See Methallyl Chloride.

METHYLAMINE (30% SOLUTION). See Monomethylamine.

N-METHYLAMINO ACETIC ACID. See Sarcosine.

METHYL p-AMINOPHENOL

Description: Colorless needles.
Formula: $CH_3NHC_6H_4OH$
Constants:
- Mol. Wt. 123.17
- M. P. 87°C

Toxic Hazard Rating:
- Acute Local: Irritant 2; Ingestion 2; Inhalation 2
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Moderate; when heated, it emits toxic fumes (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYL p-AMINOPHENOL SULFATE

Description: Colorless needles.
Formula: $(CH_3NHC_6H_4OH)_2 \cdot H_2SO_4$
Constants:
- Mol. Wt. 344.38
- M. P. 127°C (decomp.)

Toxic Hazard Rating:
- Acute Local: Irritant 2; Ingestion 2; Inhalation 2
- Acute Systemic: U
- Chronic Local: Allergen 2
- Chronic Systemic: U

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYL AMYLACETATE

Synonym: 4-Methyl pentyl 2-acetate; hexyl acetate.
Description: Clear liquid; pleasant odor.
Formula: $(CH_3)_2CH(CH_2)_3OOCCH_3$
Constants:
- Mol. Wt. 144.21
- B. P. 146.3°C
- Freezing P. −63.8°C
- Flash P. 110°F (C.O.C.)
- Density 0.8598 @20°/20°C
- Vap. Press. 3.8 mm @20°C
- Vap. D. 4.97

Toxic Hazard Rating:
- Acute Local: Irritant 1
- Acute Systemic: Ingestion 2; Inhalation 2
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

METHYL AMYL ALCOHOL

Synonyms: Methyl isobutyl carbinol; 4-methyl pentanol-2.
Description: Clear liquid.
Formula: $(CH_3)_2CHCH_2CHOHCH_3$
Constants:
- Mol. Wt. 102.2
- B. P. 131.8°C
- Freezing P. < −90°C (sets to a glass)
- Flash P. 130°F (C.O.C.)
- Density 0.8079 @20°/20°C
- Vap. Press. 2.8 mm @20°C
- Vap. D. 3.53

Toxic Hazard Rating:
- Acute Local: Irritant 1; Ingestion 2; Inhalation 2
- Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
- Chronic Local: U
- Chronic Systemic: U

MAC: ACGIH (tentative); 25 parts per million in air.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.

Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
MCA warning label.

METHYL n- AMYL KETONE

Synonym: Heptanone-2.
Description: Water-white liquid.
Formula: $CH_3(CH_2)_4COCH_3$
Constants:
Mol. Wt. 114.18
B. P. 150.6°C
Flash P. 120°F (O.C.)
Density 0.8166 @20°/20°C
Vap. Press. 2.6 mm @20°C
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3 ·
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Combustible liquid.
MCA warning label.

N- METHYLANILINE

Synonym: Monomethylaniline.
Description: Reddish-brown, oily liquid.
Formula: $C_6H_5NHCH_3$
Constants:
Mol. Wt. 107.15
M. P. −57.0°C
B. P. 195.7°C
Density 0.989 @20°/4°C
Vap. Press. 1 mm @36.0°C
Vap. D. 3.70
Toxic Hazard Rating:
Acute Local: Allergen 2
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: Allergen 2
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Caution: Both the liquid and vapor can be absorbed through the skin. See also Aniline.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of aniline; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

o-METHYLANILINE. See o-Toluidine.

METHYL BENZENE. See Toluene.

METHYL BENZOATE

Synonym: Niobe oil.
Description: Colorless liquid; fragrant odor.
Formula: $C_6H_5COOCH_3$
Constants:
Mol. Wt. 136.14
M. P. −12.5°C
B. P. 199.6°C
Flash P. 181°F
Density 1.0937
Vap. Press. 1 mm @39.0°C
Vap. D. 4.69
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

α- METHYL BENZYL ALCOHOL

Synonym: Methyl phenyl carbinol.
Description: Colorless liquid.
Formula: $C_6H_5CH(CH_3)OH$
Constants:
Mol. Wt. 122.2
B. P. 204°C
Density 1.013 @20°/4°C
Vap. Press. 1 mm @49.0°C
Vap. D. 4.22
Toxicity: Details unknown. See also Alcohols.

Fire Hazard: Moderate; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

α-METHYL BENZYLAMINE

Description: Liquid.
Formula: $C_6H_5CH(CH_3)NH_2$
Constants:
Mol. Wt. 121.18
M. P. −65°C
B. P. 188.5°C
Flash P. 175°F (O.C.)
Density 0.9535
Vap. Press. 0.5 mm @20°C
Vap. D. 4.18
Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

α-METHYL BENZYL BENZOIC ACID

Synonym: Benzoic acid α methyl benzyl ester.
Description: Crystals.
Formula: $CH_3C_6H_5CHC_6H_4COOH$
Constant:
Mol. Wt. 226.3
Toxicity: Details unknown; an insecticide. See also Esters and Benzoic Acid.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

α-METHYL BENZYL "CELLOSOLVE"

Description: Liquid.
Formula: $CH_3C_6H_4CH_2OCH_2CH_2OH$
Constants:
Mol. Wt. 166.21
B. P. 253.5°C
Freezing P. −50°C
Density 1.0395 @20°/20°C
Vap. Press. 0.02 mm @20°C
Vap. D. 5.73
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

α-METHYLBENZYL DIETHANOLAMINE

Description: Liquid.
Formula: $C_6H_5CH(CH_3)N(C_2H_4OH)_2$
Constants:
Mol. Wt. 209.28
M. P. −7°C
B. P. 244°C @50 mm
Flash P. 370°F (O.C.)
Density 1.0812 @20°/20°C
Vap. Press. < 0.01 mm @20°C
Vap. D. 7.2
Toxicity: Details unknown. See also Amines.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

α- METHYLBENZYL DIMETHYLAMINE

Description: Liquid.
Formula: $C_6H_5CH(CH_3)N(CH_3)_2$
Constants: Mol. Wt. 149.23
M. P. −75°C
B. P. 195°C
Flash P. 175°F (O.C.)
Density 0.9044 @20°/20°C
Vap. Press. 0.6 mm @20°C
Vap. D. 5.15
Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

METHYL BENZYL ETHER

Synonym: Bis-α-methyl benzyl ether.
Description: Water-white liquid.
Formula:
$C_6H_5CH(CH_3)O(CH_3)CHC_6H_5$
Constants:
Mol. Wt. 226.3
M. P. < −30°C (sets to a glass)
B. P. 286.3°C
Flash P. 275°F
Density 1.0017 @20°/20°C
Vap. Press. < 0.01 mm @20°C
Vap. D. 7.8

Toxicity: Details unknown. See also Ethers.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

α-METHYLBENZYL ETHER

Description: Liquid.
Formula:
$C_6H_5CH(CH_3)OCH(CH_3)C_6H_5$
Constants:
Mol. Wt. 226.3
M. P. −30°C
B. P. 286.3°C
Flash P. 275°F (O.C.)
Density 1.0017 @20°/20°C
Vap. Press. < 0.01 mm @20°C
Vap. D. 7.82
Toxicity: Details unknown. See also Ethers.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

α-METHYLBENZYL MONOETHANOLAMINE

Description: Liquid.
Formula: $C_6H_5CH(CH_3)NHC_2H_4OH$
Constants:
Mol. Wt. 165.23
M. P. −15°C
B. P. 182°C @50 mm
Flash P. 280°F (O.C.)
Density 1.0327 @20°/20°C
Vap. Press. < 0.01 mm @20°C
Vap. D. 5.7
Toxicity: Details unknown. See also Amines.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

METHYL BISMUTHINE

Description: Liquid.
Formula: $CH_3 \cdot BiH_2$
Constants:
Mol. Wt. 226.05
B. P. 110°C
Density 2.30 @18°C
Vap. D. 7.8
Toxicity: See Bismuth Compounds.
Fire Hazard: Moderate (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits toxic fumes of bismuth; can react with oxidizing materials.
Storage and Handling: Section 7

METHYL BORATE

Synonyms: Trimethyl borate; trimethoxy borine.
Description: Colorless liquid.
Formula: $B(OCH_3)_3$
Constants:
Mol. Wt. 103.92
M. P. −29°C
B. P. 68°C
Flash P. 60°F
Density 0.92 @20°C
Vap. D. 3.59
Toxicity: See Boron Compounds.
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Disaster Control: Dangerous; will react with water or steam to produce toxic and flammable vapors; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

METHYL BROMIDE

Synonym: Bromomethane.
Description: Colorless, transparent, volantile liquid or gas; burning taste; chloroform-like odor.
Formula: CH_3Br
Constants:
Mol. Wt. 94.95
B. P. 3.56°C
Freezing P. −93°C
Flash P. None
Density 1.732 @0°/0°C
Autoign. Temp. 998°F
Vap. D. 3.27
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3

Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
MAC: ACGIH (accepted); 20 parts per million in air; 78 milligrams per cubic meter of air.
Toxicology: Methyl bromide is reported to be 8 times more toxic on inhalation than ethyl bromide. Moreover, because of its greater volatility, methyl bromide is a much more frequent cause of poisoning. Death following acute poisoning is usually caused by its irritant effect on the lungs. In chronic poisoning, death is due to injury to the central nervous system. Fatal poisoning has always resulted from exposures to relatively high concentrations of methyl bromide vapors (from 8,600 to 60,000 ppm). Nonfatal poisoning has resulted from exposure to concentrations as low as 100 to 500 ppm. In addition to the lung and central nervous system injury mentioned, the kidneys may be damaged, with development of albuminuria and, in fatal cases, cloudy swelling and/or tubular degeneration. The liver may be enlarged. There are no characteristic blood changes.

The onset of symptoms following the inhalation of methyl bromide vapor is usually delayed for 4 to 6 hours, though the latent period may vary from 2 to 48 hours. In fatal poisoning, the early symptoms are headache, visual disturbances, nausea and vomiting, smarting of the eyes, irritation of the skin, listlessness, vertigo and tremor. Progress is nearly always rapid, with the development of convulsions,fever, pulmonary edema, cyanosis, unconsciousness and death. Signs of involvement of the nervous system may be present before death. The clinical picture in nonfatal poisoning is extremely variable. Fatigue, blurred or double vision, nausea and vomiting are frequent; incoordination, tremors, convulsions, exaggeration of the patellar reflexes and a positive Babinski's sign may develop. Nearly every type of nervous disturbances has been reported. The pulmonary symptoms are comparatively slight. Recovery is frequently prolonged and there may be permanent injury, commonly characterized by sensory disturbances, weakness, disturbances of gait, irritability, and blurred vision. Locally, methyl bromide is an extreme irritant to the skin and may produce severe burns (Section 9).
Fire Hazard: Moderate, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to sparks or flame.
Explosive Range: 13.5 - 14.5%
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification (liquid): Poison B; poison label.
Coast Guard Classification (liquid): Poison B; poison label.
MCA warning label.

2-METHYL BUTADIENE-1,3. See Isoprene.

METHYL BUTANONE. See Butanone.

METHYLBUTENE
Description: A liquid.
Formula: C_5H_{10}
Constants:
Mol. Wt. 70.1
B. P. 20 - 38°C
Freezing P. −137.8°C
Flash P. < 20°F
Density 0.648 @20°/4°C
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous, upon

exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

METHYL n-BUTYL KETONE

Synonyms: 2-Hexanone; u-butyl methyl ketone.
Description: Clear liquid.
Formula: $CH_3OC(CH_2)_3CH_3$
Constants:
Mol. Wt. 100.16
M. P. −56.9°C
B. P. 127.2°C
Flash P. 95°F (O.C.)
Density 0.830 @0°/4°C
Vap. Press. 10 mm @38.8°C
Vap. D. 3.45
Toxic Hazard Rating:
Acute Local: Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Inhalation 2
MAC: ACGIH (accepted); 100 parts per million in air; 409 milligrams per cubic meter of air.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 1.22 - 8.0%
Disaster Control: Dangerous fire and explosion hazard.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYL BUTYNOL

Synonym: 2-Methyl-3-butyn-2-ol.
Description: Colorless liquid.
Formula: $(CH_3)_2OHCCH$
Constants:
Mol. Wt. 72.1
M. P. 2.6°C
B. P. 104 - 105°C
Vap. D. 2.49
Toxicity Details unknown; probably moderately toxic.
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials.
Storage and Handling: Section 7

METHYL BUTYRATE

Description: Liquid.
Formula: $CH_3COOC_3H_7$
Constants:
Mol. Wt. 102.13
M. P. < −97°C
B. P. 102.3°C
Flash P. 57°F (C.C.)
Density 0.898
Vap. Press. 40 mm @29.6°C
Vap. D. 3.53
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYL "CARBITOL"

Synonym: Diethylene glycol monomethyl ether.
Description: Hygroscopic, water-white liquid.
Formula: $CH_3OCH_2CH_2OCH_2CH_2OH$
Constants:
Mol. Wt. 120.15
B. P. 194.2°C
Flash P. 200°F (O.C.)
Density 1.0354 @20°/4°C
Vap. Press. 0.2 mm @20°C
Vap. D. 4.14
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: Ingestion 3; Inhalation 1
Chronic Local: 0
Chronic Systemic: Ingestion 2; Inhalation 2

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYL "CARBITOL" ACETATE

Synonym: Diethylene glycol monomethyl ether acetate.
Description: Colorless liquid.
Formula: $CH_3COOC_2H_4OC_2H_4OCH_3$
Constants:
- Mol. Wt. 162.19
- B. P. 209.1°C
- Flash P. 180°F (O.C.)
- Density 1.0396 @20°/20°C
- Vap. Press. 0.12 mm @20°C

Toxic Hazard Rating:
- Acute Local: Irritant 1
- Acute Systemic: Ingestion 3; Inhalation 1
- Chronic Local: U
- Chronic Systemic: Ingestion 2; Inhalation 2

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYL "CARBITOL" FORMAL

Description: Liquid.
Formula: $CH_2(CH_3OCH_2CH_2OCH_2CH_2O)_2$
Constants:
- Mol. Wt. 252.3
- M. P. −37.4°C
- B. P. 305°C
- Flash P. 310°F
- Density 1.040
- Vap. D. 8.7

Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

METHYL "CELLOSOLVE." See Ethylene Glycol Monomethyl Ether.

METHYL "CELLOSOLVE" ACETAL. See Ethylene Glycol Monomethyl Ether Acetal.

METHYL "CELLOSOLVE" ACETATE

Synonym: Ethylene glycol monomethyl ether acetate.
Description: Colorless liquid.
Formula: $CH_3COOCH_2CH_2OCH_3$
Constants:
- Mol. Wt. 118.13
- B. P. 143°C
- Freezing P. −70°C
- Flash P. 132°F (C.C.)
- Density 1.005 @20°/20°C
- Vap. D. 4.07

Toxic Hazard Rating:
- Acute Local: Irritant 1
- Acute Systemic: Ingestion 3; Inhalation 1
- Chronic Local: U
- Chronic Systemic: Ingestion 2; Inhalation 2

MAC: ACGIH (accepted); 25 parts per million in air; 121 milligrams per cubic meter of air.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYL "CELLOSOLVE" ACETYLRICINOLEATE

Description: White crystals.
Formula: $CH_3(CH_2)_7CHOHCH_2CH\text{-}CH(CH_2)_7CO_2CH_2CH_2OH$
Constants:
- Mol. Wt. 370.6
- Vap. D. 12.8

Toxicity: Details unknown. See also Glycols and "Cellosolve."
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

METHYL CHLORIDE

Synonyms: Chloromethane.
Description: Colorless gas.
Formula: CH_3Cl
Constants:
  Mol. Wt. 50.49
  B. P. −23.7°C
  Freezing P. −97.7°C
  Flash P. Below 32°F (O.C.)
  Density 0.918 @20°/4°C
  Autoign. Temp. 1170°F
  Vap. D. 1.78
Toxic Hazard Rating:
  Acute Local: Irritant 1; Inhalation 1
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: Ingestion 2; Inhalation 2
MAC: ACGIH (accepted); 100 parts per million in air; 209 milligrams per cubic meter of air.

Toxicology: Methyl chloride has very slight irritant properties and may be inhaled without noticeable discomfort. It has some narcotic action, but this effect is weaker than that of chloroform. Acute poisoning, characterized by the narcotic effect, is rare in industry. Repeated exposure to low concentrations causes damage to the central nervous system, and, less frequently, to the liver, kidneys, bone marrow and cardiovascular system. Hemorrhages into the lungs, intestinal tract and dura have been reported. Sprayed on the skin, methyl chloride produces anesthesia through freezing of the tissue as it evaporates.

In exposures to high concentrations, dizziness, drowsiness, incoordination, confusion, nausea and vomiting, abdominal pains, hiccoughs, diplopia and dimness of vision are followed by delirium, convulsions and coma. Death may be immediate, but if the exposure is not fatal, recovery is usually slow, and degenerative changes in the central nervous system are not uncommon. The liver, kidneys, and bone marrow may be affected, with resulting acute nephritis and anemia. Death may occur several days after exposure, resulting in degenerative changes in the heart, liver and especially the kidneys.

In repeated exposures to lower concentrations there is usually fatigue, loss of appetite, muscular weakness, drowsiness, and dimness of vision. After-effects are commonly the result of damage to the central nervous system, with visual changes and attacks of depression and other psychic disturbances being reported.

Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or water spray (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 8.1 - 17.2%
Disaster Control: Dangerous; shock can shatter the compressed gas container with explosive force; when heated to decomposition, it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable gas; red gas label.
  Coast Guard Classification: Inflammable gas; red gas label.
  MCA warning label.

METHYL CHLOROFORM. See a-Trichloroethane.

METHYL CHLOROFORMATE

Synonyms: Methyl chloromethanoate; methyl chlorocarbonate.
Description: Colorless liquid.
Formula: $ClCOOCH_3$
Constants:
  Mol. Wt. 94.50
  B. P. 71.4°C
  Density 1.223 @20°/4°C
  Vap. D. 3.26
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when

heated to decomposition, it emits highly toxic fumes of methyl chloroformate and phosgene; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Corrosive liquid; white label.
  Coast Guard Classification: Corrosive liquid; white label.

METHYL CHLOROMETHOXY STEARATE

Description: Straw-yellow liquid.
Formula: $C_{20}H_{39}O_3Cl$
Constants:
  Mol. Wt. 354
  Freezing P. 8.0°C
  Flash P. 266°F (O. C.)
  Density 0.980 @20°/40°C
  Vap. D. 12.2
Toxicity: Details unknown. See also Esters.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react with oxidizing materials.
Storage and Handling: Section 7

METHYL CHLOROSULFONATE

Description: Colorless liquid; pungent odor.
Formula: CH_3OSO_2Cl
Constants:
  Mol. Wt. 130.55
  M. P. −70°C
  B. P. 135°C Decomposes
  Density 1.492 @10°C
  Vap. D. 4.51
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; will react with water, steam or acids to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

3-METHYLCHOLANTHRENE

Description: Yellow crystals.
Formula: $C_{21}H_{16}$
Constants:
  Mol. Wt. 268.3
  B. P. 280°C @80mm
  M. P. 180°C
  Density 1.28 @20°C
Toxic Hazard Rating:
  Acute Local: Irritant 2
  Acute Systemic: U
  Chronic Local: Irritant 3
  Chronic Systemic: U
Caution: Thought to be a carcinogenic agent on repeated local application.
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials (Section 6).
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

METHYL CYANIDE

Synonyms: Ethanenitrile; acetonitrile.
Description: Colorless liquid; aromatic odor.
Formula: CH_3CN
Constants:
  Mol. Wt. 41.05
  M. P. −41°C
  B. P. 80.1°C
  Flash P. 42°F (C. O. C.)
  Density 0.7868 @20°/20°C
  Vap. D. 1.42
  Vap. Press. 100 mm @27°C
Toxicity: Highly toxic. See Cyanides.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: See Cyanides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of cyanides; will react with water, steam or acids to produce toxic and flammable vapors; can react vigorously with

oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

METHYL CYANOACETATE

Description: Liquid.
Formula: $CNCH_2COOCH_3$
Constants: Mol. Wt. 99.09
M. P. -22.5°C
B. P. 203°C
Vap. D. 3.41
Toxicity: Highly toxic.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides.
Storage and Handling: Section 7

METHYL CYANOFORMATE

Description: Colorless liquid; ethereal odor.
Formula: $COOCH_3CN$
Constants: Mol. Wt. 77.06
B. P. 100°C
Density Approx. 1.00 @20°C
Vap. D. 2.66
Toxicity: Highly toxic. See Cyanides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of cyanides; will react with water, steam or acids to produce toxic fumes.
Storage and Handling: Section 7

METHYLCYCLOHEXANE

Synonyms: Hexahydrotoluene; cyclohexylmethane.
Description: Colorless liquid.
Formula: $CH_3C_6H_{11}$
Constants:
Mol. Wt. 98.18
M. P. -126.4°C
B. P. 100.3°C
Flash P. 25°F (C.C.)
Density 0.7864 @0°/4°C; 0.769 @20°/4°C
Vap. Press. 40 mm @22.0°C
Vap. D. 3.39
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Inhalation 2
Chronic Local: U
Chronic Systemic: Inhalation 1
MAC: ACGIH (accepted); 500 parts per million in air; 2000 milligrams per cubic meter of air.
Toxicology: The minimum lethal dose for rabbits via the oral route is from 4.0 to 4.5 g/kg of body weight; by inhalation, 15,000 ppm caused the death of rabbits in about 70 minutes. As to chronic effects, these are also present, since all rabbits exposed to 10,000 ppm concentrations for 6 hours a day, 5 days a week, for 2 weeks died. Not enough data are available in the literature to decide what the limits should be for human beings. However, until these limits have been agreed upon, the allowable concentration given above seems safe enough. This material does not cause irritation to the eyes and nose, and even at the level of 500 ppm, exhibitis only a very faint odor. Therefore, it cannot be said to have any warning properties. It is believed to be about 3 times as toxic as hexane and can cause death by tetanic spasm as has been noted in animals.
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 1.15% (L.E.L.)
Disaster Control: Dangerous; upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

METHYL CYCLOHEXANOL

Synonyms: Hexahydromethyl phenol; hexahydrocresol.
Description: Colorless, viscous liquid; aromatic, menthol-like odor.
Formula: $CH_3C_6H_{10}OH$
Constants: Mol. Wt. 114.1
B. P. 155 - 180°C
Flash P. 154°F (C.C.)
Density 0.924 @15.5°/15.5°C
Vap. D. 3.93

Toxic Hazard Rating:
- Acute Local: U
- Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
- Chronic Local: U
- Chronic Systemic: Ingestion 1; Inhalation 1; Skin Absorption 1

MAC: ACGIH (accepted); 100 parts per million in air; 466 milligrams per cubic meter of air.
Fire Hazard: Moderate, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; on heating it emits highly toxic fumes; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

METHYL CYCLOHEXANONE

Description: Water-white to pale yellow liquid; acetone-like odor.
Formula: $COCH(CH_3)CH_2CH_2CH_2CH_2$
Constants:
- Mol. Wt. 112.17
- B. P. 160 - 170°C
- Flash P. 118°F (C.C.)
- Density 0.925 @15°/5°C
- Vap. D. 3.86

Toxic Hazard Rating:
- Acute Local: Irritant 2
- Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
- Chronic Local: U
- Chronic Systemic: Ingestion 1; Inhalation 1; Skin Absorption 2

MAC: ACGIH (accepted); 100 parts per million in air; 458 milligrams per cubic meter of air.
Toxicology: This is a toxic compound which can damage the kidneys and the liver. It is similar to cyclohexanol in its toxic action, although it is somewhat less active. Harmful exposures in industry are rare. From experiments on rabbits, it has been found that they could withstand prolonged exposures to concentrations of from 0.02 to 0.05% by volume in air.
Fire Hazard: Moderate, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; on heating it emits highly toxic fumes; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

4-METHYLCYCLOHEXENE-1

Description: A clear liquid.
Formula: C_7H_{12}
Constants:
- Mol. Wt. 96.17
- B. P. 102.5°C
- Flash P. 30°F (T.O.C.)
- Density 0.804 @15.5°/15.5°C
- Vap. Press. 10.3 mm @38°C
- Vap. D. 3.34

Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

METHYL CYCLOHEXYL ACETATE

Synonym: Methyl cyclohexanol acetate.
Description: Liquid.
Formula: $C_9H_{16}O_2$
Constants:
- Mol. Wt. 156.22
- Flash P. 147°F (C.C.)
- Vap. D. 5.37

Toxicity: See Methyl Cyclohexanol.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon

tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

METHYL CYCLOHEXYL LACTATE
Description: Liquid.
Formula: $C_{10}H_{18}O_3$
Constants: Mol. Wt. 186.3
Flash P. 208°F
Density 1.02
Vap. D. 6.43
Toxicity: See Methyl Cyclohexanol and Lactic Acid.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

METHYL CYCLOHEXYL STEARATE
Description: Clear, oily liquid; straw yellow.
Formula: $C_{17}H_{35}COOC_6H_{10}CH_3$
Constants:
Mol. Wt. 380
M. P. 10°C
B. P. 220 - 240°F @4 mm
Flash P. 338°F
Density 0.890 @15°/15°C
Vap. D. 13.1
Toxicity: See Methyl Cyclohexanol.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

METHYL CYCLOPENTANE
Description: Colorless liquid or solid.
Formula: C_6H_{12}
Constants:
Mol. Wt. 84.16
M P. −142.5°C
B. P. 71.8°C
Flash P. < 20°F
Density 0.750 @20°/4°C
Vap. Press. 100 mm @17.9°C
Vap. D. 2.9
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

METHYL DIACETOACETATE
Description: Colorless liquid.
Formula: $(CH_3CO)_2CHCO_2CH_3$
Constants:
Mol. Wt. 158.2
Vap. D. 5.45
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight; when heated, emits acrid fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

4-METHYL-2,6-DI- tert-BUTYL-PHENOL. See Di-tert-Butyl-p-Cresol.

METHYL DICHLOROACETATE
Synonym: Methyl dichloroethanoate.
Description: Colorless liquid; ethereal odor.
Formula: $Cl_2CHCOOCH_3$
Constants:
Mol. Wt. 143.0
B. P. 143.0°C
Density 1.3809 @19.2°/19.2°C
Vap. D. 4.93
Toxicity: This material hydrolyzes upon contact with moisture to form a product corrosive to tissue. See Dichloracetic Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene.
Storage and Handling: Section 7

METHYL DICHLOROARSINE
Synonym: Methylarsenic dichloride.
Description: Colorless, mobile liquid.
Formula: CH_3AsCl_2
Constants:
Mol. Wt. 160.86

M. P. −59°C
B. P. 136°C
Density 1.838 @20°/4°C
Vap. Press. 8.5 mm @20°C
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of arsenic and chlorine; will react with water, steam or acids to produce toxic and corrosive fumes.
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Poison A; poison gas label.
  Coast Guard Classification: Poison A; poison gas label.

METHYL DICHLORSTEARATE

Description: Light yellow, oily liquid.
Formula: $C_{17}H_{33}Cl_2CO_2CH_2$
Constants:
  Mol. Wt. 367.40
  M. P. −5°C to +7°C
  B. P. 250°C Decomposes
  Flash P. 358°F
  Density 0.997 @15.5°/15.5°C
  Vap. D. 12.7
Toxicity: Probably low. See Esters.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene; can react with oxidizing materials.
Storage and Handling: Section 7

METHYL DIETHANOLAMINE

Description: Clear liquid.
Formula: $CH_3N(CH_2CH_2OH)_2$
Constants:
  Mol. Wt. 119.16
  B. P. 464°F
  Flash P. 260°F (O.C.)
  Density 1.043
  Vap. Press. 0.01 mm @20°C
Toxicity: Details unknown. See Amines.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

METHYL DIHYDROABIETATE

Description: Liquid.
Formula: $CH_3CO_2C_{19}H_{32}$
Constants:
  Mol. Wt. 319.5
  B. P. 689°F
  Flash P. 632°F
  Density 1.02
  Vap. D. 11.0
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2-METHYL-1,3-DIOXOLANE

Description: Water-white liquid.
Formula: $\underline{OCH(CH_3)OCH_2CH_2}$
Constants:
  Mol. Wt. 88.10
  B. P. 82.5°C
  Density 1.002 @0°/4°C
  Vap. D. 3.03
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYLENE ANILINE

Synonym: Hexahydro-1,3,5-triphenyl-sym-triazine.
Description: White, silky needles.
Formula: $(C_6H_5NCH_2)_3$
Constants:
  Mol. Wt. 315.40
  M. P. 141°C
  B. P. 185°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3

Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of aniline.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

N,N'-METHYLENEBISACRYLAMIDE
Description: Colorless, crystalline; stable, white powder.
Formula: $H_2C(CH_2CHCONH)_2$
Constants:
Mol. Wt. 154.17
M. P. 185°C (with decomp.)
Density 1.235 @30°C
Vap. D. 5.31
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits toxic fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

2,2'-METHYLENEBIS (4-METHYL-6-tert-BUTYLPHENOL)
Description: Pale cream to white crystals.
Formula: $C_{23}H_{33}O_2$
Constants:
Mol. Wt. 641.5
M. P. 120 - 130°C
Density 1.074 @30°C
Toxicity: Unknown
Disaster Control: Slight; when heated, it may emit toxic fumes.
Storage and Handling: Section 7

METHYLENEBIS (4-PHENYL ISOCYANATE)
Synonyms: Diphenyl methane diisocyanate.
Description: Crystals or yellow fusel solid.
Formula: $OCNC_6H_4CH_2C_6H_4NCO$
Constants:
Mol. Wt. 250.25
M. P. 37.2°C
B. P. 194 - 199°C @5 mm
Density 1.19 @50°C
Toxicity: Details unknown; an irritant.
Disaster Control: See Isocyanates.
Storage and Handling: Section 7

METHYLENE BROMIDE
Description: Colorless, heavy liquid.
Formula: CH_2Br_2
Constants:
Mol. Wt. 173.9
B. P. 95.6 - 97.4°C
Freezing P. < -50°C
Density 2.485 @25°/25°C
Vap. D. 6.05
Toxicity: Probably toxic. See Bromides.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes of bromides.
Storage and Handling: Section 7

METHYLENE CHLORIDE
Synonyms: Dichloromethane.
Description: Colorless, volatile liquid.
Formula: CH_2Cl_2
Constants:
Mol. Wt. 84.94
B. P. 40.1°C
Freezing P. −96.7°C
Density 1.326 @20°/4°C
Autoign. Temp. 1224°F
Vap. Press. 380 mm @22°C
Vap. D. 2.93
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 3; Skin Absorption 2
Chronic Local: U
Chronic Systemic: Ingestion 1; Inhalation 1; Skin Absorption 1
MAC: ACGIH (accepted); 500 parts per million in air; 1740 milligrams per cubic meter of air.
Toxicology: This material is very dangerous to the eyes. Except for its property of inducing narcosis, it has very few other toxic effects. Its narcotic powers are quite strong, and in view of its great volatility, care should be taken in its use. It will not form explosive mixtures with air at ordinary temperatures. However, it can be decomposed by contact with hot surfaces and open flame,

and it can then yield toxic fumes, which are irritating and will thus give warning of their presence. It has been used as an anesthetic in Europe and is still used there for local anesthesia. Experiments have shown that 25,000 ppm concentrations for 2 hour exposures were not lethal. Concentrations of 7,200 ppm after 8 minutes caused paresthesia of the extremities; after 16 minutes, acceleration of the pulse to 100 and during the first 20 minutes, congestion in the head, a sense of heat and slight irritation of the eyes. At a level of 2,300 ppm, there was no feeling of dizziness during one-hour exposures, but nausea did occur after 30 minutes of exposure. The limit of perception by smell is set at 25 - 50 ppm concentrations. Can cause a dermatitis upon prolonged skin contact (Section 9). A gas mask for organic vapors and fumes should be worn to avoid excessive inhalation.

Fire Hazard: None

Explosion Hazard: None under ordinary conditions, but will form explosive mixtures in atmosphere having high oxygen content.

Explosive Range: 15.5 - 66.4% in oxygen.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations: Section 11. MCA warning label.

METHYLENE CHLOROBROMIDE

Synonyms: Bromochloromethane; chlorobromomethane.

Description: Clear, colorless liquid; sweet odor.

Formula: $BrCH_2Cl$

Constants:
- Mol. Wt. 129.4
- B. P. 67.8°C
- Freezing P. −88°C
- Flash P. None
- Density 1.930 @25°/25°C
- Vap. D. 4.46

Toxicity: Details unknown. See Methylene Chloride.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of halides.

Storage and Handling: Section 7. It should not be stored in Aluminum or Magnesium containers.

p,p'- METHYLENE DIANILINE

Description: Tan flakes or lumps, faint amine-like odor.

Formula: $CH_2(C_6H_4NH_2)_2$

Constants:
- Mol. Wt. 198.3
- Freezing P. 90°C
- Flash P. 440°F

Toxicity: It has moderately high acute oral toxicity. Does not seem to be rapidly absorbed through skin in dangerous quantities or to irritate the eyes. No information regarding chronic toxicity or allergy. Tested only on rats.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of aniline.

Storage and Handling: Section 7

METHYLENE DISALICYLIC ACID

Description: Light tan, coarse powder.

Formula: $C_{15}H_{12}O_6$

Constants:
- Mol. Wt. 288.25
- M. P. 225 - 238°C
- Density 1.430 @25°/4°C

Toxic Hazard Rating:
- Acute Local: Irritant 1; Ingestion 1; Inhalation 1
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Slight; when heated, it emits acrid fumes.

Personal Hygiene: Section 3

Storage and Handling: Section 7

METHYLENE IODIDE

Synonyms: Diiodomethane.

Description: Light straw to clear colored liquid.

Formula: CH_2I_2

Constants:
- Mol. Wt. 267.9
- M. P. 5 - 6°C
- B. P. 181°C (decomp.)

Density 3.325 @20°/4°C
Vap. D. 9.25
Toxicity: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes of iodides.
Storage and Handling: Section 7

METHYLENE SUCCINIC ACID. See Itaconic Acid.

N-METHYL ETHANOLAMINE
Description: Liquid.
Formula: $CH_3NHC_2H_4OH$
Constants:
Mol. Wt. 75.11
M. P. -4.5°C
B. P. 159.5°C
Flash P. 165°F (O.C.)
Density 0.9414 @20°/20°C
Vap. Press. 0.7 mm @20°C
Vap. D. 2.59
Toxicity: Details unknown. See Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride.
Storage and Handling: Section 7

METHYL ETHER
Synonyms: Dimethyl ether; methyl oxide.
Description: Clear liquid or colorless gas.
Formula: $(CH_3)_2O$
Constants:
Mol. Wt. 46.07
M. P. -216°F
B. P. -11°F
Flash P. -42°F (C.C.)
Density 2.091 g/l
Autoign. Temp. 662°F
Vap. D. 1.59
Toxicity: Details unknown; probably has narcotic and anesthetic effects. See Ethers.
Fire Hazard: Highly dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Severe, when exposed to heat or flame.
Explosive Range: 3.45 - 18.1%
Disaster Control: Dangerous; keep containers tightly closed and away from heat or open flame; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

METHYL ETHER OF PROPYLENE GLYCOL
Description: Liquid.
Formula: $CH_3OCH_3COHCH_2OH$
Constants:
Mol. Wt. 106.1
Vap. D. 3.66
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: Ingestion 2
Chronic Local: U
Chronic Systemic: Ingestion 1; Inhalation 1
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYL ETHYL ETHER. See Ethyl Methyl Ether.

3-METHYL-4-ETHYLHEXANE
Description: Clear, colorless liquid.
Formula: C_9H_{20}
Constants:
Mol. Wt. 128.250
B. P. 140.4°C
Flash P. 75°F
Density 0.738 @25°/4°C
Vap. Press. 8.1 mm @25°C
Vap. D. 4.43
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; keep away from heat and open flame; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

METHYLETHYL KETONE. See Butanone.
MCA warning label.

METHYL ETHYL PYRIDINE
Description: Liquid.

Formula: $C_8H_{11}N$
Constants:
  Mol. Wt. 121.2
  B. P. 178.3°C
  Flash P. 160°F (O.C.)
  Density 0.920 @20°/20°C
  Vap. D. 4.18
Toxicity: Details unknown. See also Pyridine.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of nitrogen oxides; can react with oxidizing materials.
Storage and Handling: Section 7

2-METHYL-5-ETHYL PYRIDINE

Description: Liquid.
Formula: $\underbrace{NC(CH_3)CHCHC(C_2H_5)CH}$
Constants:
  Mol. Wt. 121.17
  M. P. −70.3°C
  B. P. 178.3°C
  Flash P. 165°F (O.C.)
  Density 0.9215 @20°/20°C
  Vap. Press. 0.9 mm @20°C
  Vap. D. 4.18
Toxicity: Details unknown. See also Pyridine.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

METHYL FLUORIDE

Synonym: Fluoromethane.
Description: Colorless gas.
Formula: CH_3F
Constants:
  Mol. Wt. 34.0
  M. P. −142°C
  B. P. −78.2°C
  Density 0.8774 @−78.6°/4°C
Toxicity: Details unknown; may act as a simple asphyxiant.
Disaster Control: Dangerous, shock can shatter the compressed gas container with explosive force; when heated to decomposition it emits highly toxic fumes of fluorides.
Storage and Handling: Section 7

METHYL FLUOROFORMATE

Description: Liquid.
Formula: CH_3COOF
Constants:
  Mol. Wt. 78.04
  B. P. 40°C
  Density 1.06 @33°C
  Vap. D. 2.69
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides; will react with water, steam or acids to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

METHYL FLUOROSULFONATE

Description: Liquid; ethereal odor.
Formula: CH_3OSO_2F
Constants:
  Mol. Wt. 114.09
  B. P. 92°C
  Density 1.427 @16°C
  Vap. D. 3.94
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides and oxides of sulfur; will react with water, steam or acids to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

METHYL FORMATE

Synonym: Methyl methanoate.
Description: Colorless liquid; agreeable odor.
Formula: $HCOOCH_3$

Constants:
- Mol. Wt. 60.05
- M. P. −99.8°C
- B. P. 32.0°C
- Flash P. −25.6°F (C.C.)
- Density 0.98149 @15°/4°C; 0.975 @20°/4°C
- Autoign. Temp. 840°F
- Vap. Press. 400 mm @16.0°C
- Vap. D. 2.07

Toxic Hazard Rating:
- Acute Local: Irritant 2; Ingestion 2; Inhalation 2
- Acute Systemic: Inhalation 2
- Chronic Local: U
- Chronic Systemic: U

MAC: ACGIH (accepted); 100 parts per million in air; 255 milligrams per cubic meter of air.

Toxicology: It can cause irritation to the conjunctiva and optic neuritis. Industrial exposures resulting in fatalities from this material are extremely rare, having occurred only in instances where high concentrations are encountered, as in painting the inside of a tank or working in a tank containing a residue of this material.

Exposure of guinea pigs to 5% concentrations of methyl formate vapor in air proved lethal in from 20 to 30 minutes, whereas 1.5 to 2.5% was dangerous in from 30 to 60 minutes. The maximum concentration tolerated without serious disturbance was 0.5% and the maximum concentration tolerated for several hours without serious disturbances was 0.15 - 0.20% by volume in air.

Fire Hazard: Dangerous, when exposed to heat or flame.

Spontaneous Heating: No

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Moderate, when exposed to heat or flame.

Explosive Range: 4.5 - 22.7%

Disaster Control: Dangerous, upon exposure to heat or flame; it emits toxic fumes and can react vigorously with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations: Section 11.
- I.C.C. Classification: Flammable liquid; red label.
- Coast Guard Classification: Inflammable liquid; red label.

2-METHYL FURAN

Description: Colorless, mobile liquid; ether-like odor.

Formula: C_5H_6O

Constants:
- Mol. Wt. 82.1
- B. P. 63.7°C
- Freezing P. −88.7°C
- Flash P. −16°F (T.C.C.)
- Density 0.914 @20°/4°C
- Vap. Press. 139 mm @20°C
- Vap. D. 2.8

Toxic Hazard Rating:
- Acute Local: Irritant 2; Ingestion 2
- Acute Systemic: Inhalation 2
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Dangerous, when exposed to heat or flame.

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: See Ethers.

Disaster Control: Dangerous, upon exposure to heat or flame; will emit toxic fumes on heating and can react vigorously with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

N-METHYLGLUCAMINE

Description: White crystals.

Formula: $HOCH_2(CHOH)_4CH_2NHCH_3$

Constants:
- Mol. Wt. 195.21
- M. P. 128 - 129°C

Toxic Hazard Rating:
- Acute Local: Irritant 1; Ingestion 1; Inhalation 1
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Slight; when heated, it emits toxic fumes.

Personal Hygiene: Section 3

Storage and Handling: Section 7

β-METHYLGLYCIDOL
Description: Liquid.
Formula: $\underline{OCHCH_3C}HCH_2OH$
Constants:
Mol. Wt. 88.1
Vap. D. 3.04
Toxicity: Unknown
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials.
Storage and Handling: Section 7

N-METHYLGLYCINE
Synonym: Sarcosine.
Description: Crystals.
Formula: CH_3NHCH_2COOH
Constants:
Mol. Wt. 89.1
M. P. 210°C Decomposes
B. P. Decomposes
Toxicity: Unknown
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials.
Storage and Handling: Section 7

METHYL GLYCOL ACETATE
Synonym: Propylene glycol acetate.
Description: Liquid.
Formula: $CH_2OHCHOHCH_2CO_2CH_3$
Constants:
Mol. Wt. 134.1
Flash P. 111°F (C. C.)
Vap. D. 4.62
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: Ingestion 1; Inhalation 1
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYLGLYCOCOLL. See N-Methylglycine.

METHYL HEPTADECYL KETONE
Description: White solid.
Formula: $(CH_3)(C_{17}H_{35})CO$
Constants:
Mol. Wt. 282
B. P. 165°C @3 mm
M. P. 54°C
Flash P. 255°F (C. C.)
Vap. D. 9.72
Toxicity: Unknown. See Ketones.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2-METHYLHEPTANE
Synonym: Isooctane.
Description: Colorless liquid.
Formula: $(CH_3)_3(CH_2)_4CH$
Constants:
Mol. Wt. 114.33
M. P. −109°C
B. P. 117.6°C
Flash P. 10°F (C. C.)
Density 0.6979 @20°C
Vap. Press. 10 mm @12.3°C
Vap. D. 3.93
Toxicity: Details unknown; may have narcotic or anesthetic properties.
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use moderate rate): Section 2
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

METHYL HEPTYL KETONE
Description: Colorless liquid.
Formula: $(CH_3)(C_7H_{15})CO$
Constants: Mol. Wt. 142
M. P. −9°C
B. P. 194°C
Flash P. 160°F (C. C.)
Vap. D. 4.9
Density 0.832 @30°C
Toxicity: Details unknown. See Ketones.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizng materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2-METHYLHEXANE

Synonym: Ethylisobutylmethane.
Description: Colorless liquid.
Formula: $(CH_3)_2CH(CH_2)_2CH_2CH_3$
Constants:
- Mol. Wt. 100.20
- M. P. −118.2°C
- B. P. 90.0°C
- Density 0.6789 @20°/4°C
- Vap. Press. 40 mm @14.9°C
- Vap. D. 3.45

Toxic Hazard Rating:
- Acute Local: U
- Acute Systemic: Ingestion 1; Inhalation 2
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Unknown
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride.
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

METHYL-3-HYDROXYBUTYRATE

Description: Colorless liquid.
Formula: $CH_3CHOHCH_2COOCH_3$
Constants:
- Mol. Wt. 118.13
- B. P. 174.9°C
- Flash P. 180°F
- Density 1.0559
- Vap. Press. 0.85 mm @20°C

Toxic Hazard Rating:
- Acute Local: Irritant 2
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYL IODIDE

Synonym: Iodomethane.
Description: Colorless liquid; turns brown on exposure to light.
Formula: CH_3I
Constants:
- Mol. Wt. 141.95
- M. P. −64.4°C
- B. P. 42.5°C
- Density 2.279 @20°/4°C
- Vap. Press. 400 mm @25.3°C
- Vap. D. 4.89

Toxic Hazard Rating:
- Acute Local: Irritant 2; Ingestion 2; Inhalation 2
- Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
- Chronic Local: U
- Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2

Fire Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of iodides.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYL ISOBUTYL CARBINOL

Synonym: Methyl amyl alcohol.
Description: Colorless liquid; pleasant odor.
Formula: $(CH_3)_2CHCH_2CHOHCH_3$
Constants:
- Mol. Wt. 102.17
- B. P. 131.6°C
- Freezing P. −90°C
- Flash P. 106°F (T.C.C.)
- Density 0.813 @20°/4°C
- Vap. Press. 2.20 mm @20°C
- Vap. D. 3.53

Toxic Hazard Rating:
- Acute Local: Irritant 2; Ingestion 2; Inhalation 2
- Acute Systemic: Inhalation 2
- Chronic Local: U
- Chronic Systemic: Ingestion 1; Inhalation 1; Skin Absorption 1

Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Emits toxic fumes on heating; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYL ISOBUTYL KETONE

Synonyms: 4-Methyl-2-pentanone; hexone.
Description: Colorless liquid.

Formula: $CH_3COCH_2CH(CH_3)_2$
Constants:
- Mol. Wt. 100.16
- B. P. 115.1°C
- Freezing P. −80.3°C
- Flash P. 75°F (O.C.)
- Density 0.8024 @20°/20°C
- Autoign. Temp. 860°F
- Vap. Press. 16 mm @20.0°C
- Vap. D. 3.45

Toxic Hazard Rating:
- Acute Local: Irritant 2; Ingestion 2; Inhalation 2
- Acute Systemic: Ingestion 2; Inhalation 3; Skin Absorption 2
- Chronic Local: U
- Chronic Systemic: U

MAC: ACGIH (accepted); 100 parts per million in air; 409 milligrams per cubic meter of air.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous, upon exposure to heat or flame; on heating, it emits toxic fumes; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

METHYL ISOCYANIDE

Synonym: Methyl isonitrile.
Description: Colorless liquid.
Formula: CH_3NC
Constants:
- Mol. Wt. 41.1
- M. P. −45°C
- B. P. 59.6°C
- Density 0.7464 @20°/4°C

Toxicity: Highly toxic. See Cyanides.
Explosion Hazard: Severe, when shocked or exposed to heat.
Disaster Control: Highly dangerous; shock will explode it; when heated to decomposition, it emits highly toxic fumes of cyanides.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

METHYL ISOPROPYL CARBINOL

Description: Clear liquid.
Formula: $CH_3C_3H_7CHOH$
Constants:
- Mol. Wt. 88.2
- Flash P. 103°F (C.C.)
- Vap. D. 3.04

Toxicity: Details unknown. See also Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

METHYL LACTATE

Description: Colorless liquid.
Formula: $C_4H_8O_3$
Constants:
- Mol. Wt. 116.16
- B. P. 144°C
- Flash P. 121°F (C.C.)
- Density 1.09
- Autoign. Temp. 725°F
- Vap. D. 4.02

Toxic Hazard Rating:
- Acute Local: Irritant 1; Ingestion 1; Inhalation 1
- Acute Systemic: Ingestion 1; Inhalation 1
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 22% @212°F.
Disaster Control: Moderately dangerous; vapor-air mixtures may explode; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYL MERCAPTAN

Synonym: Methanethiol.
Description: Liquid or gas.
Formula: CH_3SH
Constants: Mol. Wt. 48.10
- B. P. 7.6°C

M. P. −123.1 °C
Flash P. 0 °F
Density 0.868 @20°/4°C
Vap. D. 1.66
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (tentative); 50 parts per million in air.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; on decomposition, it emits highly toxic fumes of oxides of sulfur; will react with water, steam or acids to produce toxic and flammable vapors; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable gas; red gas label.
Coast Guard Classification: Inflammable gas; red gas label.

METHYL MERCURY DICYANDIAMIDE

Description: Crystals.
Formula: $CH_3HgNHC(NH)NHCN$
Constants: Mol. Wt. 298.7
Vap. D. 10.3
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of mercury and cyanides.
Storage and Handling: Section 7

METHYL MERCURY IODIDE

Description: Crystals.
Formula: CH_3HgI
Constants:
Mol. Wt. 342.6
Vap. D. 11.8
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury and iodides.
Storage and Handling: Section 7

METHYL METHACRYLATE (MONOMER)

Description: Colorless liquid.
Formula: $CH_2C(CH_3)COOCH_3$
Constants: Mol. Wt. 100.11
M. P. −50 °C
B. P. 101.0 °C
Flash P. 85 °F (O. C.)
Density 0.936 @20°/4°C
Vap. Press. 40 mm @25.5 °C
Vap. D. 3.45
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: Ingestion 1; Inhalation 1
Chronic Local: U
Chronic Systemic: Ingestion 1; Inhalation 1
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
MCA warning label.

METHYL MONOCHLOROACETATE

Description: Clear liquid.
Formula: $CH_2ClCOOCH_3$
Constants: Mol. Wt. 108.53
B. P. 132 °C
Flash P. 116 °F (C. C.)
Density 1.227
Vap. D. 3.74
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

N-METHYL MORPHOLINE
Description: Liquid.
Formula: $\underbrace{C_2H_4OC_2H_4}NCH_3$
Constants: Mol. Wt. 101.2
M. P. -65.9°C
B. P. 115.4°C
Flash P. 75°F (O. C.)
Density 0.9213
Vap. D. 3.35
Toxicity: Details unknown. See also Morpholine.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use moderate rate): Section 2
Disaster Control: Dangerous, upon exposure to heat or flame; can emit toxic fumes on heating; can react with oxidizing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

METHYL NITRATE
Description: Colorless liquid.
Formula: CH_3NO_3
Constants:
Mol. Wt. 77.04
B. P. 65°C (explodes)
Density 1.206 @20°/4°C
Vap. D. 2.66
Toxicity: Details unknown. See Nitrates.
Fire Hazard: See Nitrates.
Explosion Hazard: Severe, when shocked or exposed to heat. A rocket fuel.
Disaster Control: Dangerous! See Nitrates.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

METHYL NITRITE
Description: Gas.
Formula: CH_3ONO
Constants:
Mol. Wt. 61.04
M. P. -17°C
B. P. -12°C
Density 0.991 @15°C
Toxicity: Details unknown. See Nitrites.
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Severe, when exposed to heat or flame.
Disaster Control: Highly dangerous; when heated, it emits highly toxic fumes of oxides of nitrogen; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

1-METHYL-3-NITRO-1-NITROSO GUANIDINE
Description: Crystals.
Formula: $C_2H_5N_5O_3$
Constant:
Mol. Wt. 147.1
Toxicity: Unknown
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

METHYL NONYL KETONE
Description: Colorless liquid.
Formula: $(CH_3)(C_9H_{19})CO$
Constants:
Mol. Wt. 170
M. P. 12°C
B. P. 223°C
Flash P. 192°F (C. C.)
Density 0.829 @30°C
Vap. D. 4.87
Toxicity: Details unknown. See Ketones.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

9-METHYLOL CARBAZOLE
Description: Crystals.
Formula: $(C_6H_4)_2NCH_2OH$

Constant:
Mol. Wt. 197.2
Toxicity: Details unknown; a fumigant. Probably toxic.
Disaster Control: Moderately dangerous in a disaster because, when heated, it emits highly toxic fumes of nitrogen oxides; can react on contact with oxidizing materials.
Storage and Handling: Section 7

METHYLOL PINENE

Description: Water-white to light straw-colored liquid.
Formula: $C_{11}H_{17}OH$
Constants:
Mol. Wt. 146.3
B. P. 111°C @10 mm
Density 0.963 @25°C
Vap. D. 5.05
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

METHYL ORANGE

Synonyms: Helianthine B; Orange III
Description: Orange-yellow powder.
Formula: $C_{14}H_{14}N_3NaO_3S$
Constant:
Mol. Wt. 327.3
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

METHYL PARATHION

Description: A solid or powder.
Toxicity: See Parathion.
Explosion Hazard: Moderate, when exposed to heat (120°C).
Disaster Control: Moderately dangerous; when heated, it emits highly toxic fumes and may explode; can react with oxidizing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

METHYL PENTADIENE

Description: Liquid.
Formula: C_6H_{10}
Constants:
Mol. Wt. 82.14
B. P. 75 - 77°C
Flash P. -30°F
Density 0.7184 @20°/4°C
Vap. D. 2.83
Toxicity: Unknown
Fire Hazard: Highly dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous! Keep away from heat and open flame.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

2-METHYLPENTANE

Synonym: Dimethylpropylmethane.
Description: Colorless liquid.
Formula: $(CH_3)_2CH(CH_2)_2CH_3$
Constants:
Mol. Wt. 86.17
B. P. 60°C
Freezing P. -154°C
Flash P. < 20°F
Density 0.654 @20°/4°C
Vap. Press. 400 mm @41.6°C
Vap. D. 2.97
Toxicity: Details unknown; may have narcotic or anesthetic properties.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; keep away from heat and open flame; reacts vigorously with oxidizing agents.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

3-METHYLPENTANE

Synonym: Diethylmethylmethane.
Description: Colorless liquid.
Formula: C_6H_{14}
Constants:
Mol. Wt. 86.17
B. P. 63.3°C
Freezing P. -118°C (sets to a glass)
Flash P. < 20°F
Density 0.664 @20°/4°C
Vap. Press. 100 mm @10.5°C
Vap. D. 2.97

Toxicity: Details unknown; may have narcotic or anesthetic properties.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

2-METHYL-2,4-PENTANEDIOL

Synonym: α,α,α-Trimethyl trimethylene glycol.
Description: Liquid.
Formula: $(CH_3)_2COHCH_2CHOHCH_3$
Constants:
  Mol. Wt. 118.2
  B. P. 196°C
  Flash P. 202°F
  Density 0.9240 @17°/4°C
  Vap. Press. 10.8 mm @95°C
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

3-METHYLPENTANEDIOL-1,5

Description: Clear liquid.
Formula:
  $HOCH_2CH_2CH(CH_3)CH_2CH_2OH$
Constants:
  Mol. Wt. 118.17
  B. P. 248.4°C
  Freezing P. −60°C
  Density 0.9755 @20°/20°C
  Vap. Press. < 0.01 mm @20°C
  Vap. D. 4
Toxicity: Details unknown. See also Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, dry chemical, carbon dioxide or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2-METHYL PENTANOL-1

Description: Liquid.
Formula:
  $CH_3CH_2CH_2CH(CH_3)CH_2OH$
Constants:
  Mol. Wt. 102.17
  B. P. 147.5°C
  Flash P. 135°F (O.C.)
  Density 0.8230 @20°/20°C
  Vap. D. 3.52
Toxicity: Details unknown. See also Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

4-METHYL PENTANOL-2

Synonyms: Isobutylmethylcarbinol; methyl amyl alcohol.
Description: Colorless, stable liquid.
Formula: $(CH_3)_2CHCH_2CHOHCH_3$
Constants:
  Mol. Wt. 102.17
  B. P. 131.4°C
  Density 0.8156 @20°/4°C
  Vap. D. 3.53
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Slight when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-METHYL-1-PENTENE

Synonym: 1-Methyl-1-propyl ethylene.
Description: Liquid.
Formula: $CH_2C(CH_3)CH_2CH_2CH_3$
Constants:
  Mol. Wt. 84.2
  M. P. −135.8°C
  B. P. 62°C
  Flash P. −18°F
  Density 0.684 @15.5°/15.5°C

Vap. Press. 326 mm @37.3°C
Vap. D. 290
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

2-METHYLPENTENE-2
Description: A liquid.
Formula: C_6H_{12}
Constants:
Mol. Wt. 84.2
B. P. 66.9°C
Flash P. < 20°F
Density 0.690 @15.5°/15.5°C
Vap. Press. 326 mm @38°C
Vap. D. 2.9
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

4-METHYLPENTENE
Description: A liquid.
Formula: C_6H_{12}
Constants:
Mol. Wt. 84.2
M. P. −153.6°C
B. P. 54°C
Flash P. < 20°F
Density 0.668 @15.5°/15.5°C
Vap. Press. 424 mm @38°C
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

4-METHYL-2-PENTENE
Synonym: 1-Isopropyl-2-methyl ethylene.
Description: Liquid.
Formula: $CH_3CHCHCH(CH_3)_2$
Constants:
Mol. Wt. 84.16
M. P. −134.4°C
B. P. 58°C
Density 0.670 @20°/4°C
Vap. D. 2.90
Toxicity: Unknown
Fire Hazard: Moderate; when heated, it emits acrid fumes; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

METHYL PENTYNOL
Synonym: 3-Methyl-1-pentyn-3-ol.
Description: Colorless liquid.
Formula: $HC\vdots CC(OH)CH_3C_2H_5$
Constants:
Mol. Wt. 98.14
M. P. −30.6°C
B. P. 121 - 122°C
Density 0.8688 @20°C
Vap. D. 3.38
Toxicity: Unknown
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials.
Storage and Handling: Section 7

METHYL PHENYLACETATE
Description: Colorless liquid.
Formula: $C_6H_5CH_2COOCH_3$
Constants: Mol. Wt. 150.17
Density 1.062
Vap. D. 5.18
Toxicity: Details unknown. See Esters.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

3-METHYL-1-PHENYL-5-PYRAZOLONE
Description: White powder.
Formula: $C_6H_5N_2COCH_2CCH_3$

Constants:
  Mol. Wt. 174.2
  M. P. 128.9°C
  B. P. 191°C @7 mm
Toxicity: Unknown.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react with oxidizing materials.
Storage and Handling: Section 7

METHYL PHOSPHINE
Description: Colorless gas.
Formula: CH_3PH_2
Constants:
  Mol. Wt. 48.0
  B. P. -14°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Inhalation 3
  Chronic Local: U
  Chronic Systemic: Inhalation 3
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Unknown.
Disaster Control: Dangerous; when heated, it emits highly toxic fumes of oxides of phosphorus; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

METHYL PHTHALYL ETHYL GLYCOLLATE
Description: Liquid.
Formula:
  $CH_3CO_2C_6H_4CO_2CH_2CO_2C_2H_5$
Constants:
  Mol. Wt. 266.2
  B. P. 590°F
  Flash P. 375°F (C. C.)
  Density 1.220
  Vap. D. 9.16
Toxicity: Details unknown. See Esters.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2-METHYL PIPERAZINE
Description: A hygroscopic solid; typical amine-like odor.
Formula: $C_5H_{12}N_2$
Constants:
  Mol. Wt. 100.1
  M. P. 65.5°C
  B. P. 155.6°C @746 mm
  Flash P. 163.4°F (C. O. C.)
Toxicity: Unknown.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, or dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2-METHYL-2-PROPANETHIOL
Synonym: t-Butyl mercaptan.
Description: Liquid.
Formula: $C_4H_{10}S$
Constants:
  Mol. Wt. 90.2
  M. P. -115.9°C
  B. P. 98°C
  Density 0.800 @20°C
  Vap. Press. 181.5 mm @25°C
  Vap. D. 3.11
Toxicity: Detials unknown. See Mercaptans.
Fire Hazard: Moderate.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, emits highly toxic fumes of oxides of sulfur; can react with oxidizing materials.
Storage and Handling: Section 7

2-METHYL PROPENE. See Isobutylene.

METHYL PROPIONATE
Description: Colorless liquid.
Formula: $CH_3CH_2COOCH_3$
Constants:
  Mol. Wt. 88.15
  M. P. -87.5°C
  B. P. 79.8°C
  Flash P. 28°F (C. C.)
  Density 0.937 @4°C
  Autoign Temp. 876°F
  Vap. Press. 40 mm @11.0°C
  Vap. D. 3.03
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1; Inhalation 1
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U

Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown.
Disaster Control: Dangerous; keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYL PROPYL CARBINOL

Synonym: dl-Pentanol-2
Description: Water-white liquid.
Formula: $CH_3CH_2CH_2CH(OH)CH_3$
Constants:
  Mol. Wt. 88.2
  B. P. 119°C
  Flash P. 105°F (C. C.)
  Density 0.8303 @20°/4°C
  Vap. D. 3.03
Toxicity: Details unknown. See also Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

METHYL n-PROPYL KETONE.

See Pentanone-2.

2-METHYLPYRAZINE

Description: Liquid, pyridine-like odor.
Formula: $C_5H_6N_2$
Constants:
  Mol. Wt. 94.12
  M. P. -29°C
  B. P. 133°C @737 mm
  Flash P. 122°F (C. O. C.)
  Density 1.0224 @25°/25°C
  Vap. D. 3.2
Toxicity: Details unknown.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of nitrogen oxides; can react with oxidizing materials.
Storage and Handling: Section 7

1-1-METHYL-2-β-PYRIDYLPYRROLIDINE

Description: Pale straw-colored liquid.
Formula: $C_{10}H_{10}N_2$
Constants:
  Mol. Wt. 158.2
  B. P. 247°C
  Density 1.01 @20°/20°C
  Vap. D. 5.46
Toxicity: Unknown.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react with oxidizing materials.
Storage and Handling: Section 7

N-METHYL-2-PYRROLIDONE

Synonym: 1-Methyl-2-pyrrolidone.
Description: Colorless liquid; mild odor.
Formula: $H_3C\underline{NCH_2CH_2CH_2CO}$
Constants:
  Mol. Wt. 99.13
  B. P. 202°C
  Freezing P. -24°C
  Flash P. 204°F
  Density 1.027 @25°/4°C
Toxicity: Unknown.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

METHYL SALICYLATE

Synonym: Oil of wintergreen.
Description: Colorless, yellowish or reddish, oily liquid.
Formula: $2\text{-}HOC_6H_4\text{-}1\text{-}COOCH_3$
Constants:
  Mol. Wt. 152.14
  B. P. 223.3°C
  Flash P. 214°F (C. C.)
  Freezing P. -1.2°C
  Density 1.1840 @20.2°/4°C
  Autoign Temp. 850°F
  Vap. Press. 1 mm @54.0°C
  Vap. D. 5.24
Toxic Hazard Rating:
  Acute Local: Irritant 2; Allergen gen 1; Ingestion 2
  Acute Systemic: Ingestion 3

Chronic Local: Allergen 1
Chronic Systemic: U
Toxicology: Accidental acute poisoning is not uncommon. Kidney irritation, vomiting and convulsions occur.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
Underwriters Laboratory Classification: 20 - 25.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYL SELENIDE. See Dimethyl Selenide.

o-METHYL SILICATE

Description: Clear liquid.
Formula: $Si(OCH_3)_4$
Constants:
Mol. Wt. 152.2
Vap. D. 5.25
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: Irritant 2
Chronic Systemic: Ingestion 2; Inhalation 2
Toxicology: This material can cause extensive necrosis (experimental), keratoconus and opaque cornea; it also causes severe human eye injuries, as well as necrosis of corneal cells, which progresses long after the exposure has ceased. It is destructive and its effects resist treatment. Permanent blindness is possible from exposure to it. Both the liquid and vapor of this material are dangerous to the eyes. From animal experimentation, the minimum lethal dose by oral administration has been found to be 0.07 ml/100 g of body weight for the rat and 0.01 ml/100 g of body weight intravenously for the rabbit. Administration of this material to animals resulted in death from within a few hours to a few days.

The kidney seems to be the organ which is usually injured, regardless of the mode of administration of the toxic material. In less severe cases, degeneration of the convoluted tubules was found, with complete degeneration of the organ in the more severe cases. Pulmonary edema also occurred in those animals who had received intravenous injections. It has been reported that exposure to methyl silicate vapor under certain conditions of humidity or exposure to the liquid may cause the eye damages noted above. This material was found to be more toxic to animals than either ethyl silicate or silicic acid, although it has been thought that the injury caused is largely due to the action of the silicic acid.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYL STEARATE

Description: Liquid to semi-solid.
Formula: $C_{17}H_{35}CO_2CH_3$
Constants: Mol. Wt. 298.5
M. P. 38°C
B. P. 215°C @15 mm
Flash P. 307°F (C. C.)
Density 0.860
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

METHYL STYRENE

Description: Liquid.
Formula: C_9H_{10}
Constants: Mol. Wt. 118.17
M. P. -23.21°C
B. P. 165.4°C
Flash P. 136°F
Density 0.9062 @25°/25°C
Vap. Press. 1 mm @7.4°C
Vap. D. 4.08
Toxic Hazard Rating:
Acute Local: Irritant 2; Inhalation 2

Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Toxicology: From animal studies it appears that immediate deaths occur from primary action on the central nervous system, whereas delayed deaths come about from pneumonia.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 0.9% (L.E.L.)
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYLSTYRYL PHENYL KETONE

Description: Liquid.
Formula: $C_{16}H_{14}O$
Constants:
Mol. Wt. 222.3
Vap. D. 7.67
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYL SULFATE. See Dimethyl Sulfate.

METHYL SULFIDE

Synonyms: Methylthiomethane; dimethyl sulfide.
Description: Colorless liquid; disagreeable odor, soluable in alcohol and ether.
Formula: $(CH_3)_2S$
Constants:
Mol. Wt. 62.13
M. P. −83.2°C
B. P. 37.5° - 38°C
Density 0.8458 @21°/4°C
Vap. D. 2.14
Toxicity: Details unknown; probably highly toxic. See Sulfides.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate.
Explosive Range: 0.8% (L.E.L.)
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur, and may explode; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

METHYL SULFITE

Synonym: Dimethyl sulfite.
Description: Colorless liquid.
Formula: $(CH_3)_2SO_3$
Constants:
Mol. Wt. 110.1
B. P. 126°C
Density 1.242 @0°/0°C
Vap. D. 3.8
Toxicity: Details unknown, an irritant and probably toxic material.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; it will react with water, steam or acids to produce toxic and corrosive fumes; can react with oxidizing materials.
Storage and Handling: Section 7

N-**METHYLTAURINE.** See 2-(N-Methylamino) Ethane Sulfonic Acid.

METHYL TELLURIDE

Synonym: Dimethyl telluride.
Description: Yellow liquid.
Formula: $(CH_3)_2Te$
Constants:
Mol. Wt. 157.7
B. P. 82°C
Vap. D. 5.45
Toxicity: See Tellurium Compounds.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of tellurium; will react with water or steam to produce toxic and flammable vapors; can react with oxidizing materials.
Storage and Handling: Section 7

2-METHYL TETRAHYDROFURAN
Synonyms: Tetrahydromethylfuran; tetrahydrosylvan.
Description: Colorless, mobile liquid; ether-like odor.
Formula: $\underbrace{OCH_2CH_2CH_2C}HCH_3$
Constants:
Mol. Wt. 86.13
B. P. 80°C
Flash P. 10°F (O. C.)
Density 0.853 @20°/4°C
Vap. D. 2.97
Toxicity: Unknown.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown.
Disaster Control: Dangerous; keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

METHYL TOLUENE SULFONATE
Description: Light brown crystals.
Formula: $CH_3C_6H_4SO_3CH_3$
Constants:
Mol. Wt. 186.22
Density 1.230 - 1.238 @25°/25°C
Vap. D. 6.45 M. P. 28°C
Toxicity: Unknown.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

METHYL TRICHLOROSILANE
Description: A liquid.
Formula: CH_3Cl_3Si
Constants:
Mol. Wt. 149.46
M. P. −90°C
B. P. 66.5°C
Density 1.28 @25°/25°C
Vap. D. 5.17
Toxicity: See Chlorosilanes.
Disaster Control: See Chlorosilanes.
Storage and Handling: Section 7

METHYL TRIETHOXYSILANE
Description: Liquid.
Formula: $C_7H_{18}O_3Si$
Constants:
Mol. Wt. 178.20
B. P. 141°C
Density 0.890
Vap. D. 6.14
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits toxic fumes; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYL TRIPHENYLSILICONE
Synonym: Methyltriphenylsilane.
Description: Crystals.
Formula: $CH_3(C_6H_5)_3Si$
Constants:
Mol. Wt. 274.4
M. P. 67.3°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

METHYL UNDECYL KETONE
Description: Colorless liquid or white solid.
Formula: $(CH_3)(C_{11}H_{23})CO$
Constants:
Mol. Wt. 198
M. P. 28°C
B. P. 120°C @5 mm
Flash P. 225°F (C. C.)
Vap. D. 6.84
Density 0.825 @30°C
Toxicity: Details unknown. See Ketones.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

Toxic Rating Code: 0 = None 1 = Slight 2 = Moderate 3 = High U = Unknown

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

METHYLUREA
Description: Crystals.
Formula: $NH_2CONHCH_3$
Constants: Mol. Wt. 74.1
M. P. 101°C B. P. Decomp.
Density 1.205 @20°/20°C
Toxicity: Details unknown; probably low.
Fire Hazard: Slight; when heated, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

METHYL VINYL ETHER
Description: Liquid or gas.
Formula: $CHCH_2OCH_3$
Constants: Mol. Wt. 58.1
M. P. −122°C
B. P. 41°F
Flash P. −60°F
Vap. D. 2.0
Toxicity: Details unknown; probably has narcotic and anesthetic properties. See also Ethers.
Fire Hazard: Highly dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical, carbon tetrachloride or water spray (Section 6).
Explosion Hazard: Details unknown. See also Ethers.
Disaster Control: Dangerous; keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

METHYL VINYL KETONE
Synonym: 3-Butene-2-one.
Description: Colorless liquid, powerfully irritating odor.
Formula: $CH_3COCHCH_2$
Constants: Mol. Wt. 70.09
B. P. 81.4°C
Flash P. 20°F (C.C.)
Density 0.8393 @ 25°/4°C
Vap. D. 2.41
Toxicity: Skin irritant and lachrymator.
Fire Hazard: Dangerous; when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous, upon exposure to heat or flame; emits toxic and irritant fumes; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

MICA DUST (BELOW 5% FREE SILICA)
Description: Light gray to dark flakes or particles.
Toxic Hazard Rating:
Acute Local: Irritant 2; Inhalation 2
Acute Systemic: 0
Chronic Local: Inhalation 2
Chronic Systemic: 0
MAC: ACGIH (accepted); 20 million particles per cubic foot of air.
Caution: Can cause a chronic fibrosis of the lungs.
Ventilation Control (use normal rate): Section 7

MILITARY GUNCOTTON. See Cellulose Nitrate.

MILL DUST
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 1; Inhalation 2
Acute Systemic: 0
Chronic Local: Inhalation 2
Chronic Systemic: Inhalation 1
MAC: ACGIH (accepted); 50 million particles per cubic foot of air.
Ventilation Control (use normal rate): Section 2

MILLON'S BASE
Description: Crystals.
Formula: $(HO)_2Hg_2NH_2OH$
Constants: Mol. Wt. 468.27
Density 4.083 @18°C
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: See Mercury Compounds, Inorganic.
Storage and Handling: Section 7

MINERAL DUSTS
Toxicity: Variable. From the economic and toxicologic standpoint, the most important are those

containing free silica, which can cause silicosis if inhaled in sufficient quantity. These include sand, sandstone, quartz and flint. They consist mainly of silica in the form of quartz, diatomaceous earth, which is essentially amorphous silica, and granite, which contains from 20 to 40% quartz. Minerals that contain combined silica in the form of silicates but no free silica are generally less capable of causing silicosis. Asbestos, however, can cause a fibrotic lung condition of its own, known as asbestosis (See Asbestos). Mica and talc dust are also considered somewhat hazardous (See Mica Dust). Nonsiliceous minerals, like limestone, marble, dolomite, etc., which do not contain toxic elements, do not ordinarily present any significant dust hazard, although minerals containing toxic elements, such as cryolite, which contains fluorine, and pyrolusite, which contains manganese, may cause systemic poisoning if the dust is inhaled or ingested in sufficient quantity. In any event, the minerals are usually less reactive than synthetic compounds of the same elements, and in fact may be relatively inert by comparison.

MINERAL SEAL OIL

Synonym: Signal oil.
Description: A viscous liquid.
Constant:
  Flash P. 170°F (C.C.)
Toxicity: Details unknown. See also Kerosene.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

MINERAL SPIRITS NO. 10

Synonyms: Turpentine substitute; white spirit.
Description: A clear, water-white liquid.
Constants:
  B. P. 150 - 190°C
  Flash P. 104°F (C.C.)
  Density 0.80
  Autoign. Temp. 473°F
  Vap. D. 3.9
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1; Inhalation 1
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 0.77% at 212°F.
Disaster Control: Dangerous; may explode on heating.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

MIRBANE OIL. See Nitrobenzene.

MIXED ACID. See Sulfuric Acid and Nitric Acid.
Shipping Regulations: Section 11.
  Coast Guard Classification: Corrosive liquid; white label.
  MCA warning label.

MIXTURES OF HYDROFLUORIC AND SULFURIC ACIDS. See Hydrofluoric and Sulfuric Acids.
Shipping Regulations: Section 11.
  Coast Guard Classification: Corrosive liquid; white label.

MOHAIR

Synonym: Goathair.
Description: A fabric.
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: Inhalation 1
  Chronic Local: Allergen 1
  Chronic Systemic: Inhalation 1
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Slight, in the form of dust, when exposed to flame. See also Dust Explosions.
Personal Hygiene: Section 3
Storage and Handling: Section 7

MOLYBDENUM

Description: Cubic, silver-white, metallic crystals or gray-black powder.

Formula: Mo
Constants:
At Wt. 95.95
M. P. 2622°C
B. P. 5560°C
Density 10.2
Vap. Press. 1 mm @3102°C
Radiation Hazard (Section 5): Artificial isotope Mo^{99}, half-life: 67 hours; emits beta particles of 0.5 and 1.2 mev and gamma rays of 0.81, 0.36 and 0.73 mev. The permissible levels are: In body: 50 microcuries; in air: 2×10^{-3} microcurie per milliliter; in water: 14 microcurie per milliliter.
Fire Hazard: Moderate, in the form of dust, when exposed to heat or flame; can react with oxidizing materials. See also Powdered Metals (Section 6).
Explosion Hazard: Slight, in the form of dust, when exposed to flame. See also Powdered Metals.
Storage and Handling: Section 7

MOLYBDENUM CARBONYL

Description: Diamagnetic crystals.
Formula: $Mo(CO)_6$
Constants:
Mol. Wt. 264.01
M. P. Decomposes @150°C
Density 1.96
Vap. Press. 2.3 mm @55°C
Vap. D. 9.1
Toxicity: See Carbonyls.
Caution: In stable form this compound is not highly toxic, but it may liberate carbon monoxide because it decomposes easily.
Fiee Hazard: See Carbonyls.
Explosion Hazard: See Carbonyls.
Disaster Control: See Carbonyls.
Storage and Handling: Section 7

MOLYBDENUM CHLORIDE

Synonym: Molybdenum dichloride.
Description: Amorphous or yellow crystals.
Formula: $MoCl_2$
Constants:
Mol. Wt. 166.86
M. P. Decomposes
Density 3.714 @25°C
Toxicity: See Molybdenum Compounds.
Disaster Control: Slightly dangerous; when heated to decomposition, it emits toxic fumes of chlorides.
Personal Hygiene: Section 3
Storage and Handling: Section 7

MOLYBDENUM COMPOUNDS

Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: Inhalation 1
MAC: ACGIH (tentative); soluble compounds, 5 milligrams per cubic meter of air; insoluble compounds, 15 milligrams per cubic meter of air.
Toxicology: Molybdenum and its compounds are said to be somewhat toxic, but in spite of their considerable use in industry, industrial poisoning by molybdenum has yet to be reported. Some studies have been made of its toxic effects, and it is suggested that suitable precautions should be taken against the inhalation of considerable amounts of the more soluble molybdenum compounds. From animal experimentation, it was found that no fatalities occurred to those subjected to molybdic oxide fumes for 25 one hour exposures at an average concentration of 1.5 mg/cu. foot of air, and only 1 fatality in 24 one hour exposures to molybdenite dust at an average concentration of 8.1 mg/cu. foot of air. Molybdenum is not stored in the body to any extent because it is rapidly excreted. Experiments with the sodium salts of hexavalent chromium, tungsten and molybdenum have shown that sodium molybdate is the least toxic of the three, and is less toxic following intraperitoneal injection than either sodium chromate or sodium tungstate in equivalent concentrations. All molybdenum compounds can be referred to molybdenum or to more toxic anions if present.

Recent studies have shown that molybdenum has importance as a trace element in the normal growth and development of certain forms of plant life. It is found also in animal tissue, although its precise function is unknown.

MOLYBDENUM DISULFIDE. See Molybdenum Sulfide.

MOLYBDENUM HEXAFLUORIDE

Description: Colorless crystals or liquid.
Formula: MoF_6
Constants:
Mol. Wt. 209.95
M. P. 17°C
B. P. 35°C
Density 2.55
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

MOLYBDENUM MONOBORIDE

Description: Crystals.
Formula: MoB
Constants: Mol. Wt. 106.77
Density 8.65
Toxicity: See Boron Compounds and Molybdenum Compounds.
Fire Hazard: See Borides.
Explosion Hazard: Details unknown. See also Borides.
Disaster Control: See Borides.
Personal Hygiene: Section 3
Storage and Handling: Section 7

MOLYBDENUM OXIDE

Synonym: Molybdenum sesquioxide.
Description: Gray-black powder.
Formula: Mo_2O_3
Constants:
Mol. Wt. 239.90
Toxicity: See Molybdenum Compounds.
Ventilation Control (use normal rate): Section 2

MOLYBDENUM OXYTETRAFLUORIDE

Description: Colorless-white, deliquescent crystals.
Formula: $MoOF_4$
Constants:
Mol. Wt. 187.95
M. P. 98°C
B. P. 180°C
Density 3.0
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

MOLYBDENUM PENTASULFIDE

Description: Dark brown powder.
Formula: Mo_2S_5
Constant:
Mol. Wt. 352.23
Toxicity: Highly toxic. See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

MOLYBDENUM PHOSPHIDE

Description: Gray-green crystalline powder.
Formula: MoP
Constants:
Mol. Wt. 126.93
Density 6.167
Toxicity: See Phosphides.
Fire Hazard: See Phosphides.
Explosion Hazard: See Phosphides.
Disaster Control: See Phosphides.
Storage and Handling: Section 7

MOLYBDENUM SESQUISULFIDE

Description: Steel-gray needles.
Formula: Mo_2S_3
Constants:
Mol. Wt. 288.10
M. P. Decomposes @1100°C
B. P. Volat. @ 1200°C
Density 5.91 @15°C
Toxicity: Highly toxic. See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

MOLYBDENUM SULFIDE

Synonyms: Molybdic sulfide; molybdenite.
Description: Black, lustrous powder.
Formula: MoS_2
Constants:
Mol. Wt. 160.07
M. P. 1185°C
B. P. Decomposes in air.
Density 4.80 @14°C
Toxicity: Unknown

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

MOLYBDENUM TETRABROMIDE

Description: Black, deliquescent needles.
Formula: $MoBr_4$
Constants:
Mol. Wt. 415.61
M. P. Decomposes
B. P. Volatilizes
Toxicity: See Bromides and Molybdenum Compounds.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes of bromides.
Storage and Handling: Section 7

MOLYBDENUM TETRASULFIDE

Description: Brown powder.
Formula: MoS_4
Constants:
Mol. Wt. 224.19
M. P. Decomposes
Toxicity: Highly toxic. See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

MOLYBDENUM TRISULFIDE

Description: Red-dark brown crystals.
Formula: MoS_3
Constants:
Mol. Wt. 192.13
M. P. Decomposes
B. P. Decomposes
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

MOLYBDIC ACID

Description: Hexagonal, white or slight yellowish crystals.
Formula: H_2MoO_4
Constants:
Mol. Wt. 162.0
M. P. Decomp. 115°C
Density 3.112
Toxicity: See Molybdenum Compounds.

MOND GAS. See Carbon Monoxide and Hydrogen.

MONO-sec-AMYLAMINE

Description: Colorless liquid; amine-like odor.
Formula: $CH_3(CH_2)_2CH(CH_3)NH_2$
Constants:
Mol. Wt. 87.16
B. P. 92°C
Flash P. 20°F
Density 0.73839 @20°/0°C
Vap. D. 3.01
Toxicity: Details unknown. See Amines.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

N-MONOAMYL ANILINE

Description: Liquid.
Formula: $C_5H_{11}NHC_6H_5$
Constants:
Mol. Wt. 163.3
B. P. 473°F
Flash P. 225°F
Density 0.9
Vap. D. 5.63
Toxicity: Probably toxic. See Aniline.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of aniline; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

MONO n-BUTYLAMINE

Description: Colorless liquid.
Formula: $CH_3(CH_2)_2CH_2NH_2$
Constants: Mol. Wt. 73.14
M. P. −50.5°C

Flash P. 10°F (O.C.)
Density 0.7401 @20.4°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
MCA warning label.

MONO-sec-BUTYLAMINE

Description: Colorless liquid.
Formula: $CH_3CH(NH_2)CH_2CH_3$
Constants:
Mol. Wt. 73.14
M. P. -104.5°C
B. P. 63°C
Flash P. 15°F
Density 0.724 @20°/4°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

MONOBUTYLAMINE OLEATE

Description: Liquid.
Formula: $C_{17}H_{33}CO_2NH_3C_4H_9$
Constants: Mol. Wt. 355.6
Flash P. 150°F
Density 0.891
Vap. D. 12.3
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

MONO-tert-BUTYL-m-CRESOL

Description: Clear liquid.
Formula: $(CH_3)_3CC_6H_3(CH_3)OH$
Constants:
Mol. Wt. 164.24
M. P. 27.0°C
B. P. 137°C @25 mm
Density 0.969 @30°/25°C
Vap. D. 5.77
Toxicity: Details unknown. See Cresol.
Disaster Control: Moderately dangerous; when heated, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

MONOCHLOROACETIC ACID

Synonym: Chloroethanoic acid; chloroacetic acid.
Description: Colorless crystals.
Formula: $CH_2ClCOOH$
Constants:
Mol. Wt. 94.5
M. P. α = 63°C; β = 56°C; γ = 50°C
B. P. 189°C
Flash P. None
Density 1.58 @20°/20°C
Vap. D. 3.26
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene and chlorides.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

MONOCHLOROACETONE, STABILIZED

Synonym: Monochlorated acetone.
Description: Colorless liquid; pungent odor.
Formula: CH_3COOCH_2Cl
Constants:
  Mol. Wt. 92.52
  B. P. 119°C
  Density 1.162 @16°C
  Vap. D. 3.2
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Poison C; tear gas label.
  Coast Guard Classification: Poison C; tear gas label.

MONOCHLOROACETONE, UNSTABLIZED. See Monochloroacetone, Stablized.
Shipping Regulations: Section 11.
  I. C. C. Classification: Not accepted.
  Coast Guard Classification: Not permitted.

MONOCHLOROBENZENE. See Chlorobenzene.

MONOCHLORODIFLUOROMETHANE

Description: Colorless gas.
Formula: $CHClF_2$
Constants:
  Mol. Wt. 86.48
  M. P. −146°C
  B. P. −40.8°C
  Density 3.87 @0°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Inhalation 2
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene and fluorine.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Nonflammable gas; green label.
  Coast Guard Classification: Noninflammable gas; green gas label.

MONOCHLOROMALEIC ANHYDRIDE

Description: Nearly white liquid or solid.
Formula: $ClCCH(CO)_2O$
Constants:
  Mol. Wt. 132.5
  M. P. 33°C
  B. P. 196 - 197.5°C
  Density 1.54 @25°/25°C
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosgene.
Storage and Handling: Section 7

MONOCHLOROMETHANE. See Methyl Chloride.

MONOCHLOROMONOBROMO METHANE

Synonym: Monochlorobromomethane.
Description: Liquid.
Formula: CH_2BrCl
Constants:
  Mol. Wt. 129
  B. P. 60 - 90°C
  Vap. D. 4.45
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
  Chronic Local: U
  Chronic Systemic: Inhalation 2; Skin Absorption 2
Toxicology: This material has a narcotic action of moderate intensity, although of prolonged duration. Animals exposed for several weeks to 1,000 ppm of this substance had blood bromide levels as high as 350 mg/100 grams of blood. Therefore, until further data are available concerning it, it should be

considered at least as toxic as carbon tetrachloride, and more than minimal exposure to its vapors should be avoided.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and bromides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

MONOCHLORONAPHTHALENE

See Chlorinated Naphthalenes.

MONOCHLOROTETRAFLUOROETHANE

Description: Gas.
Formula: C_2HF_4Cl
Constant:
Mol. Wt. 136.49
Toxicity: Details unknown; probably acts as a simple asphyxiant. See also Chlorinated Hydrocarbons.
Disaster Control: Dangerous; shock can shatter the compressed gas container and release it; when heated to decomposition it emits highly toxic fumes of chlorides and fluorides.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Nonflammable gas; green label.
Coast Guard Classification: Noninflammable gas; green gas label.

MONOCHLOROTOLUENE

Synonym: Methylchlorobenzene.
Description: Clear, colorless to straw-colored liquid.
Formula: $CH_3C_6H_4Cl$
Constants:
Mol. Wt. 126.5
B. P. 158 - 165°C
Freezing P. $< -45°C$
Flash P. 125°F
Density 1.080 @15.5°/15.5°C
Vap. D. 4.38
Toxicity: Details unknown. See also Toluene.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react with oxidizing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
MCA warning label.

MONOCHLOROTRIFLUOROMETHANE

Synonym: Chlorotrifluoromethane.
Description: Colorless gas; ethereal odor.
Formula: $CClF_3$
Constants:
Mol. Wt. 104.47
M. P. −181°C
B. P. −80°C
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: Inhalation 2
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; shock can shatter the compressed gas container and release it; when heated to decomposition, it emits highly toxic fumes of chlorides and fluorides.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Nonflammable gas; green label.
Coast Guard Classification: Noninflammable gas; green gas label.

MONOCRESYL DIPHENYL PHOSPHATE

Description: Liquid.
Formula: $CH_3C_6H_4O(C_6H_5O)_2PO_4$
Constants:
Mol. Wt. 388.3
Flash P. 450°F (C. C.)
Density > 1
Vap. D. 13.4
Toxicity: Details unknown; probably toxic and an irritant.
Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide or dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when

heated to decomposition, it emits highly toxic fumes of oxides of phosphorus; can react with oxidizing materials.
Storage and Handling: Section 7

MONODECYL NAPHTHALENE

Description: Straw-colored liquid.
Constants:
B. P. 341 - 420°C
Flash P. 325°F
Density 0.968 @20°C
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

MONODODECYL BENZENE. See Keryl Benzene-12.

MONOETHANOL AMINE

Synonym: 2-Aminoethanol.
Description: Colorless liquid; ammoniacal odor.
Formula: $NH_2CH_2CH_2OH$
Constants:
Mol. Wt. 61.08
B. P. 170.5°C
Freezing P. 10.5°C
Flash P. 200°F (O.C.)
Density 1.0180 @20°/4°C
Vap. Press. 6 mm @60°C
Vap. D. 2.11
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

MONOFLUOPHOSPHORIC ACID

Description: Colorless, viscous liquid.
Formula: H_2PO_3F
Constants:
Mol. Wt. 100
Density 1.818 @25°/4°C
Vap. D. 3.45
Toxicity: Highly toxic. See Fluorides and Phosphoric Acid.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid of acid fumes, it emits highly toxic fumes of fluorides.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

MONOFLUOROPHOSPHORIC ACID, ANHYDROUS. See Monofluophosphoric Acid.
Shipping Regulations: Section 11.
I.C.C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

MONOFLUOROTRICHLOROMETHANE

Description: Colorless liquid.
Formula: CCl_3F
Constants:
Mol. Wt. 137.4
M. P. -111°C
B. P. 24.1°C
Density 1.494 @17.2°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: Ingestion 2; Inhalation 1; Skin Absorption 1
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (accepted); 1000 parts per million in air; 5600 milligrams per cubic meter of air.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and fluorides.
Storage and Handling: Section 7

MONOGERMANE

Synonym: Germanium tetrahydride.
Description: Gas
Formula: GeH_4
Constants:
Mol. Wt. 76.63
M. P. -165°C
B. P. -88.5°C
Density Liquid: 1.523 @-142°C
gas: 3.43 g/l
Toxicity: Details unknown. See

also Hydrides and Germanium Compounds.
Fire Hazard: Dangerous. See Hydrides.
Explosion Hazard: Dangerous. See Hydrides.
Disaster Control: See Hydrides.
Storage and Handling: Section 7

MONO-sec-HEXYLAMINE

Synonym: 2-Amino-4-methyl pentane.
Description: Water-white liquid; amine-like odor.
Formula: $CH_3CHNH_2C_4H_9$
Constants:
  Mol. Wt. 101.19
  Flash P. 55°F
  Density 0.746 @20°C
  Vap. D. 3.49
Toxicity: Details unknown. See also Amines.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

MONOISOPROPANOLAMINE

Description: Colorless liquid.
Formula: $CH_3CH(OH)CH_2NH_2$
Constants:
  Mol. Wt. 75.11
  B. P. 159.9°C
  Freezing P. −2°C
  Flash P. 160°F (O.C.)
  Density 0.9619 @20°/20°C
  Vap. Press. 0.6 mm @20°C
  Vap. D. 2.59
Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

MONOMETHYLAMINE

Synonym: Aminomethane.
Description: Colorless gas or liquid; strong ammoniacal odor.
Formula: CH_3NH_2
Constants:
  Mol. Wt. 31.1
  B. P. −6.79°C
  Frezing P. −93.5°C
  Flash P. 0°F (C.C.)
  Density 0.662 @20°/4°C
  Autoign. P. 806°F
  Vap. D. 1.07
Toxicity: Details unknown. See also Amines.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to sparks or flame.
Explosive Range: 4.95 - 20.75%
Disaster Control: Dangerous; keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

MONOMETHYLAMINE, ANHYDROUS

See Monomethylamine.
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable gas; red gas label.
  Coast Guard Classification: Inflammable gas; red gas label.

MONOMETHYLAMINE, AQUEOUS SOLUTION.

See Monomethyl Amine.
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Inflammable liquid; red label.

MONOMETHYLANILINE

Description: Reddish-brown oily liquid.
Formula: $C_6H_5NHCH_3$
Constants:
  Mol. Wt. 107.15
  M. P. −57.0°C
  B. P. 195.7°C
  Density 0.986 @20°/4°C
  Vap. D. 3.7
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3;

Inhalation 3; Skin Absorption 3
Chronic Local: Irritant 1
Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of aniline; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

MONOMETHYLOL DIMETHYL HYDANTOIN

Description: Odorless, white crystalline solid.
Formula: $C_6H_{10}N_2O_3$
Constants:
Mol. Wt. 158.16
M. P. 99 - 103°C
Density 0.78
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits toxic fumes (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

MONONITROTOLUENE. See p-Nitrotoluene.

MONONONYL NAPHTHALENE

Description: Light straw-colored viscous liquid.
Formula: $C_9H_{19}C_{10}H_7$
Constants:
Mol. Wt. 254.4
B. P. 300 - 350°C
Density 0.93 - 0.94 @20°C
Vap. D. 8.8
Toxicity: Details unknown. See also Naphthalene.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

MONO n-PROPYLAMINE

Description: Colorless liquid; amine-like odor.
Formula: $CH_3(CH_2)_2NH_2$
Constants:
Mol. Wt. 59.11
M. P. −83°C
B. P. 48.7°C
Flash P. < 20°F
Density 0.719
Vap. D. 2.04
Toxicity: Details unknown. See also Amines.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous, upon exposure to heat or flame; on decomposition it emits toxic fumes of nitrogen oxides; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

MONOPROPYLENE GLYCOL METHYL ETHER

Synonym: 1-Methoxy-2-propanol.
Description: Clear, colorless liquid.
Formula: $CH_3OCH_2CH(OH)CH_3$
Constants:
Mol. Wt. 90.1
B. P. 120°C
Flash P. 102°F
Density 0.92 @25°/20°C
Vap. D. 3.1
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Details unknown. See also Ethers.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

MONOTHIOGLYCEROL

Description: Liquid.
Formula: $C_3H_8O_2S$

Constants:
  Mol. Wt. 108.2
  B. P. 118°C @5 mm
  Density 1.248 @20°/20°C
Toxicity: Details unknown. See also Glycerol.
Fire Hazard: Moderate.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react with oxidizing materials.
Storage and Handling: Section 7

MORPHINE

Description: White, crystalline alkaloid.
Formula: $C_{17}H_{19}NO_3 \cdot H_2O$
Constants:
  Mol. Wt. 303.35
  M. P. Anh. 254°C Decomposes
  B. P. 191 - 192°C (vacuum)
  Density 1.317
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3
  Chronic Local: U
  Chronic Systemic: Ingestion 3

Toxicology: Morphine is the constituent of opium most responsible for its poisonous effects. When taken orally, the effects of morphine poisoning begin to appear in 20 to 40 minutes; if taken hypodermically, the symptoms appear much earlier and narcotism is more likely to follow the early symptoms. Individual susceptibility varies greatly and children are more susceptible than adults. The usual symptoms due to an overdose of morphine are a sense of mental exhilaration and physical ease with a quickening and strengthening of the pulse and then a depression of the brain with special reference to its higher functions. Smaller doses which are not sufficient to cause this depression do cause a diminished sensibility to lasting impressions, such as pain, cold, hunger and discomfort. Following this there may be dizziness and heaviness of the head, nausea, languor and drowsiness, the pulse being reduced in frequency for some time before it is reduced in force. Individuals with great susceptibility may complain of itching of the skin and even erythema and as the action continues, it produces sleep. There is a gradual loss of muscular power and a diminished sense of feeling. The pupils become contracted and fail to respond to light. The respirations become less and less frequent, finally being reduced in some cases to four or five a minute with stertorous breathing. If the patient who has taken an overdose of morphine survives for 48 hours, the prognosis is favorable.

Treatment and Antidotes: A physician should be called at once. The stomach should be washed repeatedly and at short intervals, whether the poison was taken by mouth or injection, since it is excreted into the stomach anyway. Emetics should be given. Recommended is apomorphine hydrochloride, hypodermically. If narcosis has already set in, the effect of the emetic may be interfered with. A dilute solution of potassium permanganate in the form of a lavage which should be 0.5 gram per liter has been used successfully. Tincture of belladonna by mouth, 2 cc by volume, may be repeated every 15 minutes but this antidote must be used cautiously. Solubility of the morphine in the stomach may be decreased by giving tannic acid, coffee, tea and finally, powdered charcoal in water, also an iodine solution may be given. Every effort should be made to arouse the patient and keep him awake, especially by walking him around, pinching the skin, slapping him, and by ammonia inhalations and artificial respiration if necessary. Keep the patient warm under any conditions. The fatal dose may be from 1 to 2 to 4 or 6 grains, depending very much upon the individual.

Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

MORPHINE ACETATE. See Morphine.

MORPHINE HYDROCHLORIDE. See Morphine.

MORPHINE MECONATE. See Morphine.

MORPHINE NITRATE

Description: White powder, darkens when exposed to light.
Formula: $C_{17}H_{19}NO_3 \cdot HNO_3$
Constant:
Mol. Wt. 348.26
Toxicity: See Morphine and Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

MORPHINE SULFATE. See Morphine.

MORPHOLINE

Synonyms: Tetrahydro-1,4-oxazine; diethylenimide oxide.
Description: Colorless, hygroscopic oil.
Formula: $\overline{OCH_2CH_2NHCH_2CH_2}$
Constants:
Mol. Wt. 87.12
B. P. 128.9°C
Freezing P. −7.5°C
Flash P. 100°F (O.C.)
Density 0.998 @25°/25°C
Autoign. Temp. 590°F
Vap. Press. 10 mm @23°C
Vap. D. 3.00
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to flame or heat.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
MCA warning label.

MORPHOLINE ETHANOL

Synonym: N-hydroxy ethyl morpholine.
Description: Colorless liquid.
Formula: $O(CH_2CH_2)_2NCH_2CH_2OH$
Constants:
Mol. Wt. 131.17
B. P. 225.5°C
Flash P. 210°F
Density 1.071
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

MORTAR STAIN, LIQUID

Toxicity: Variable.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: combustible liquid; inflammable liquid, red label.

MOTH BALLS. See Naphthalene.

MOTH FLAKES. See Naphthalene.

MOTION PICTURE FILM, NITROCELLULOSE BASE

Fire Hazard: Dangerous, when exposed to heat or flame. See also Nitrocellulose (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame. See also Nitrocellulose.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of

nitrogen; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

MOTION PICTURE FILM, SLOW BURNING

Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react with oxidizing materials.
Storage and Handling: Section 7

MOTOR FUEL ANTIKNOCK COMPOUND. See Lead Tetraethyl.
Shipping Regulations: Section 11.
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

MOTOR FUEL, N.O.S. See Gasoline.
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable liquid; red label.
Coast Guard Classification: combustible liquid; inflammable liquid, red label.

MUIRA PUAMA

Description: A wood.
Composition: Aromatic resin, muira puamine, fat.
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2
Acute Systemic: Ingestion 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Slight, in the form of dust, when exposed to heat or flame. See also Dust Explosions.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

MURIATIC ACID. See Hydrochloric Acid.
Shipping Regulations: Section 11.
Coast Guard Classification: Corrosive liquid; red label.
MCA warning label.

MUSTARD GAS. See β,β'-Dichloroethyl Sulfide.
Shipping Regulations: Section 11.
I.C.C. Classification: Poison A; poison gas label - not accepted.
Coast Guard Classification: Poison A; poison gas label.

N

NaK

Description: Liquid or solid, metallic alloy.

Toxicity: See Sodium and Potassium.

Toxicology: NaK as its name implies is a low melting alloy of Na and K. Its toxicity is that of either Na or K alone. In contact with moisture this material reacts very violently to evolve hydrogen and much heat, leaving behind a highly caustic residue of NaOH or KOH. Of course the heat would damage tissue as would the caustic residue. Even fine particles of NaK would damage the eyes, irritate the lungs, etc. Finally when NaK burns it evolves quantities of finely divided fumes of Na_2O, K_2O which is a powerful caustic.

Fire Hazard: Dangerous. In the presence of oxygen, moisture, halogens, oxidizers, acids or acid fumes, etc., it will react violently giving off much heat, often either spattering red hot particles or actually flaming.

To Fight Fire: G-1 powder, dry sodium chloride or dry soda ash. Never use water, foam or carbon tetrachloride (Section 6).

Explosion Hazard: Severe. It will react explosively under many conditions such as contact with moisture, halogens, acid solutions, mists and fumes, powerful oxidizing agents and many organic compounds containing oxygen or halogen.

Disaster Control: Dangerous; when heated, emits highly toxic fumes of sodium and potassium oxide; it will react explosively with water, steam, acid, acid fumes or mists to produce heat, hydrogen, toxic and corrosive fumes; can react very vigorously with oxidizing materials. See also Sodium and Potassium.

Ventilation Control (use complete enclosure): Section 2

Storage and Handling: Store in a cool place, preferably under kerosene (Section 7).

NAPHTHA (COAL-TAR)

Synonyms: Hi-flash naphtha; 160° benzol.

Description: Dark, straw-colored to colorless liquid.

Composition: Benzene, toluene, xylene, etc.

Constants:
- B. P. 149 - 216°C
- Flash P. 100°F (C.C.)
- Density 0.862 - 0.892
- Autoign. Temp. 900 - 950°F

Toxic Hazard Rating:
- Acute Local: Irritant 2; Ingestion 2; Inhalation 1
- Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
- Chronic Local: Irritant 1
- Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3

MAC: ACGIH (accepted); 200 parts per million in air.

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials. Keep containers tightly closed.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Slight.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations: Section 11.
- I.C.C. Classification: Flammable liquid; red label.
- Coast Guard Classification: Combustible liquid; inflammable liquid, red label.

NAPHTHALENE

Synonyms: Moth flakes; white tar;

tar camphor.
Description: Aromatic odor; white, crystalline, volatile flakes.
Formula: $C_{10}H_8$
Constants:
  Mol. Wt. 128.16
  M. P. 80.1°C
  B. P. 217.9°C (Sublimes)
  Flash P. 176°F
  Density 1.145
  Autoign. Temp. 1038°F
  Vap. Press. 1 mm @52.6°C
  Vap. D. 4.42
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 1
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: Irritant 1
  Chronic Systemic: Ingestion 1; Inhalation 1
Fire Hazard: Moderate, when exposed to heat or flame; reacts with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, in the form of dust, when exposed to heat or flame.
Explosive Range: 0.9 - 5.9%
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  Coast Guard Classification: Hazardous article.

NAPHTHALENE-1, 5-DISULFONIC ACID

Description: Crystals.
Formula: $C_{10}H_6(SO_3H)_2$
Constant:
  Mol. Wt. 288.3
Toxicity: Details unknown. See also Naphthalene.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

NAPHTHA (PETROLEUM)

Synonyms: Petroleum ether.
Description: Clear, colorless, volatile liquid.
Composition: A mixture of the lighter constituents of petroleum.
Constants:
  B. P. 40 - 70°C
  Flash P. 0°F
  Density 0.630 - 0.660
  Vap. D. 4.48
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1; Inhalation 1
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: Irritant 1
  Chronic Systemic: U
MAC: ACGIH (accepted); 500 parts per million in air.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 1.1 - 4.8%
Disaster Control: Dangerous; keep away from heat and open flame; keep containers tightly closed; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Combustible liquid; inflammable liquid, red label.

NAPHTHA, SAFETY SOLVENT

Synonyms: Stoddard solvent; white spirits.
Description: Colorless, clear, volatile liquid petroleum distillate.
Constants:
  M. P. Below −45°F
  B. P. 400°F
  Flash P. 100 - 110°F
  Density 0.8
  Autoign. Temp. 450 - 500°F
Toxicity: Details unknown. See also Kerosene.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon

dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame. Keep containers tightly closed.
Explosive Range: 1.1 - 6.0%
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

NAPHTHA, SOLVENT. See Naphtha (Coal-Tar).
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Combustible liquid; inflammable liquid, red label.

NAPHTHA, V.M.&P.

Synonyms: Benzine; 76° naphtha.
Description: Volatile liquid.
Constants:
  B. P. 100 - 140°C
  Flash P. 20°F (C.C.)
  Density 0.67 - 0.80
  Autoign. Temp. 450°F
Toxicity: See Naphtha (Petroleum).
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 0.9 - 6.0% at 212°F.
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

α-NAPHTHOL

Synonyms: 1-Naphthol; 1-hydroxynaphthalene.
Description: Colorless crystals; disagreeable taste.
Formula: $C_{10}H_7OH$
Constants:
  Mol. Wt. 144.2
  M. P. 96°C
  B. P. 282.5°C
  Density 1.0954 @98.7°/4°C
  Vap. Press. 1 mm @94.0°C
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 1
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: Irritant 2
  Chronic Systemic: Ingestion 1; Inhalation 1; Skin Absorption 1
Toxicology: The naphthols are thought to be more toxic than naphthalene, the β-naphthol being slightly less toxic than the α derivative. They are an irritant to the skin and mucous membranes and may cause dermatitis (Section 9). It is reported that sufficient naphthol may be absorbed through the skin to cause irritation of the kidneys and injury to the cornea and lens of the eye.
Fire Hazard: Slight; when heated, it emits toxic fumes (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

β-NAPHTHOL

Synonyms: β-hydroxynaphthalene; isonaphthol.
Description: White to yellowish-white crystals; slight phenolic odor.
Formula: $C_{10}H_7OH$
Constants:
  Mol. Wt. 144.2
  M. P. 122.5°C
  B. P. 288.0°C
  Flash P. 322°F
  Density 1.22
  Vap. Press. 10 mm @145.5°C
  Vap. D. 4.97
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 1
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: Irritant 2
  Chronic Systemic: Ingestion 1; Inhalation 1; Skin Absorption 1
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated it emits toxic fumes.
Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-NAPHTHOL-3-CARBOXYLIC ACID
Synonyms: β-Oxynaphthoic acid; 3-hydroxy-β-naphthoic acid.
Description: Yellow crystals.
Formula: $HOC_{10}H_6COOH$
Constants:
Mol. Wt. 188.2
M. P. 216°C
Toxicity: Details unknown. See α- and β-Naphthols.
Fire Hazard: Slight; when heated, it emits toxic fumes; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

2-NAPHTHOL-3,6-DISULFONIC ACID. See Sodium β-naphthol Disulfonate.

1,4-NAPHTHOQUINONE
Description: Greenish-yellow powder.
Formula: $C_{10}H_6O_2$
Constants: Mol. Wt. 158.1
M. P. 123 - 126°C
B. P. Sublimes @100°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 1; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits toxic fumes (Section 6).
Storage and Handling: Section 7

NAPHTHORESORCINOL
Synonym: 1,3-Dihydroxynaphthalene.
Description: White, crystalline leaves or plates.
Formula: $C_{10}H_8O_2$
Constants:
Mol. Wt. 160.2
M. P. 124 - 125°C
Toxicity: Details unknown. See Naphthalene.
Fire Hazard: Slight; when heated, it emits toxic fumes (Section 6).
Storage and Handling: Section 7

α-NAPHTHYLAMINE
Description: White crystals.
Formula: $C_{10}H_7NH_2$
Constants:
Mol. Wt. 143.18
M. P. 50°C
B. P. 300.8°C
Flash P. 315°F
Density 1.131
Vap. Press. 1 mm @104.3°C
Vap. D. 4.93
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Toxicology: It has little importance as an industrial hazard except that a commercial grade may contain up to 10% β-naphthylamine. Because of this β content, it may theoretically give rise to bladder tumors after prolonged exposure. The highest incidence of bladder cancer is in the manufacture of organic intermediates in which β-naphthylamine and benzidine are known factors and aniline and alpha-naphthylamine are possible factors.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials; when heated it emits toxic fumes.
Spontaneous Heating: No.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

β-NAPHTHYLAMINE
Description: White to faint pink, lustrous leaflets; faint aromatic odor.
Formula: $C_{10}H_7NH_2$
Constants:
Mol. Wt. 143.18
M. P. 111.5°C
B. P. 306.0°C

Density 1.061 @98°/4°C
Vap. Press. 1 mm @108.0°C
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Toxicology: It is not corrosive or dangerously reactive, but it is a very toxic chemical in any of its physical forms, such as flake, lump, dust, liquid or vapor. It can be absorbed into the body through the lungs, the gastrointestinal tract or skin. Long and continued exposure to even small amounts may produce tumors and cancers of the bladder. It is combustible and at elevated temperatures evolves a vapor which is flammable and explosive. The explosive limit of these vapors has not yet been determined. Repeated exposure may result in bladder tumors.
Fire Hazard: Slight, when exposed to heat or flame; when heated it emits toxic fumes (Section 6).
Ventilation Control (use high rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

α-NAPHTHYL ISOCYANATE
Formula: $C_{11}H_7NO$
Constants:
Mol. Wt. 169.2
M. P. 4°C
B. P. 269 - 270°C
Density 1.179 @25°C
Toxicity: Details unknown. Probably toxic. See Cyanates.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of cyanides.
Storage and Handling: Section 7

α-NAPHTHYL ISOTHIOCYANATE
Description: White, odorless, tasteless needles.
Formula: $C_{10}H_7NCS$
Constants:
Mol. Wt. 185.2
M. P. 58°C
Density 1.81
Toxicity: Details unknown; see also Thiocyanates.
Disaster Control: See Thiocyanates.
Storage and Handling: Section 7

2-NAPHTHYL MERCAPTAN
Toxicity: Details unknown; a mosquito larvicide. See also Mercaptans.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

α-NAPHTHYLTHIOREA (30% and over)
Description: Crystals.
Formula: $C_{11}H_{10}N_2S$
Constants:
Mol. Wt. 202.3
M. P. 198°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2
Acute Systemic: Ingestion 3; Inhalation 2
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
Disaster Control: Dangerous; on decomposition it emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

NATURAL GAS. See Gases, Hydrocarbon.

NEATSFOOT OIL
Description: Pale yellow liquid.
Constants:
M. P. 84 - 106°F
Flash P. 470°F (C. C.)
Density 0.92
Autoign Temp. 828°F
Toxicity: Unknown.
Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: Yes.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

NEOARSPHENAMINE
Synonym: Neosalvarsan.
Description: Yellow, almost odorless powder.

Formula: (partially) $NH_2OHC_6H_3As$-$AsC_6H_3OHNH(CH_2O)OSNa$
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

NEODYMIUM

Description: Yellowish, metallic crystals.
Formula: Nd
Constants:
At. Wt. 144.27
M. P. 840°C
Density 6.9
Toxicity: Unknown.
Radiation Hazard: Section 5. Artificial isotope Nd^{147}, half-life 12 days; emits beta particles of 0.9 mev (60%) and 0.4 mev (40%) and gamma rays of 0.51 mev. Hazard Rating, Class II (National Bureau of Standards Handbook No. 42).
Fire Hazard: Moderate, in the form of dust, when exposed to heat or flame. See also Powdered Metals (Section 6).
Explosion Hazard: Slight, in the form of dust, when exposed to flame. See also Powdered Metals.

NEODYMIUM BROMATE

Description: Hexagonal, red crystals.
Formula: $Nd(BrO_3)_3 \cdot 9H_2O$
Constants:
Mol. Wt. 690.16
M. P. 66.7°C
B. P. − $9H_2O$ @150°C
Toxicity: Details unknown. See also Bromates.
Fire Hazard: A moderate fire hazard by chemical reaction. A powerful oxidizer.
Disaster Control: Moderately dangerous in a disaster because, when heated, it emits highly toxic fumes of bromides; can react vigorously with reducing materials.
Storage and Handling: Section 7

NEODYMIUM BROMIDE

Description: Green crystals.
Formula: $NdBr_3$
Constant:
Mol. Wt. 384.02
Toxicity: Details unknown. See also Bromides.
Disaster Control: Slightly dangerous in a disaster because, when heated, it emits highly toxic fumes of bromine.
Storage and Handling: Section 7

NEODYMIUM CARBIDE

Description: Hexagonal, yellow leaflet.
Formula: NdC_2
Constants: Mol. Wt. 168.29
M. P. Decomposes
Density 5.15
Toxicity: Unknown.
Fire Hazard: A moderate fire hazard by chemical reaction. See Carbides.
Explosion Hazard: Slight by chemical reaction with moisture and acids.
Disaster Control: Slight; it will react with water or steam to produce flammable vapors.
Storage and Handling: Section 7

NEODYMIUM IODIDE

Description: Black, crystalline powder.
Formula: NdI_3
Constants:
Mol. Wt. 525.03
M. P. 775 ± 3°C
Toxicity: Details unknown. See also Iodides.
Disaster Control: Slight; when heated, it emits highly toxic fumes of iodine.
Storage and Handling: Section 7

NEODYMIUM NITRATE

Description: Triclinic crystals.
Formula: $Nd(NO_3)_3 . 6H_2O$
Constant:
Mol. Wt. 438.39
Toxicity: Details unknown. See also Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

NEODYMIUM NITRIDE

Description: Black powder.
Formula: NdN
Constant:
Mol. Wt. 158.28
See Ammonia, Anhydrous.

NEODYMIUM OXALATE
Description: Rose crystals.
Formula: $Nd_2(C_2O_4)_3 \cdot 10H_2O$
Constant:
Mol. Wt. 732.76
Toxicity: Details unknown. See also Oxalates.
Disaster Control: See Oxalates.
Storage and Handling: Section 7

NEODYMIUM SULFIDE
Description: Olive-green powder.
Formula: Nd_2S_3
Constants:
Mol. Wt. 384.72
M. P. Decomposes
Density 5.179 @11°C
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

NEOHEXANE
Synonym: 2,2-Dimethylbutane.
Description: A clear, volatile liquid.
Formula: $(CH_3)_3CCH_2CH_3$
Constants: Mol. Wt. 86.2
M. P. −98.2°C
B. P. 49.7°C
Density 0.6487 @20°/4°C
Toxicity: Unknown.
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; keep away from sparks, heat and flame. Keep containers tightly closed.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

NEON
Description: Colorless, wholly inert gas.
Formula: Ne
Constants:
At. Wt. 20.18
M. P. −248.67°C
B. P. −245.9°C
Density 0.9002 g/liter @0°C; liquid = 1.204 @−245.9°C
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Inhalation 1
Chronic Local: 0
Chronic Systemic: U
Disaster Control: Slightly dangerous; shock can shatter the compressed gas container with explosive force.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Nonflammable gas; green label.
Coast Guard Classification: Noninflammable gas; green gas label.

NEOPENTYL GLYCOL
Synonym: 2,2-Dimethyl 1,3-propanediol.
Description: White, crystalline solid.
Formula: $C_5H_{12}O_2$
Constants:
Mol. Wt. 104.2
M. P. 121 - 126°C
B. P. 207 - 212°C
Toxicity: Details unknown; an insect repellent. See also Glycols.
Fire Hazard: Slight; when heated, it emits acrid fumes; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

NEPTUNIUM
Description: A radioactive, artificially produced element.
Formula: Np
Constant:
At. Wt. 239
Toxicity: Unknown.
Radiation Hazard: Section 5. Artificial isotope Np^{239}, half-life 2.3 days; emits many beta particles between 0.2 - 1.2 mev and many gamma rays between 0.06 - 0.5 mev. Np^{239} is produced in nuclear reactors by the process, $U^{238} + n \longrightarrow U^{239} \longrightarrow Np^{239} + \beta$, and is the source of Pu^{239} when it decays.

NERVE GAS. See Tabun and Sarin.

NICKEL
Description: Cubic, silvery, metallic crystals.
Formula: Ni
Constants:
At. Wt. 58.69
M. P. 1452°C
B. P. 2900°C
Density 8.90
Vap. Press. 1 mm @1810°C

Toxicity: See Nickel Compounds.
Radiation Hazard: Section 5. Artificial isotope Ni^{59}, half-life 1.5×10^5 years. The permissible levels are: in body: 39 microcuries; in air: 2×10^{-5} microcurie per milliliter; in water: 0.25 microcurie per milliliter.
Fire Hazard: Moderate, in the form of dust, when exposed to heat or flame. See also Powdered Metals (Section 6).
Explosion Hazard: Slight, in the form of dust when exposed to flame. See also Powdered Metals.

NICKEL ACETATE
Description: Green prisms.
Formula: $Ni(C_2H_3O_2)_2$
Constants:
Mol. Wt. 176.8
M. P. Decomposes
Density 1.798
Toxicity: See Nickel Compounds.

NICKEL AMMONIUM NITRATE
Synonym: Nickel nitrate tetraamine.
Description: Green crystals.
Formula: $Ni(NO_3)_2 . 4NH_3 . 2H_2O$
Constant:
Mol. Wt. 286.87
Toxicity: See Nickel Compounds and Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

NICKEL ANTIMONIDE
Synonym: Breithauptite.
Description: Hexagonal, light copper-red crystals.
Formula: NiSb
Constants:
Mol. Wt. 180.45
M. P. 1158°C
B. P. Decomp. @1400°C
Density 7.54
Toxicity: Highly toxic. See Antimony Compounds.
Fire Hazard: Moderate, by chemical reaction with water to form stibine. See also Hydrides (Section 6).
Explosion Hazard: Slight, when exposed to flame; can evolve stibine. See also Hydrides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of antimony; it will react with water, steam or acids to produce toxic and flammable vapors; it can react with oxidizing materials.
Storage and Handling: Section 7

NICKEL ARSENATE
Synonym: Nickel o-arsenate.
Description: Yellowish-green powder.
Formula: $Ni_3(AsO_4)_2$
Constants:
Mol. Wt. 435.89
Density 4.98
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

NICKEL ARSENIDE
Synonym: Niccolite.
Description: Hexagonal crystals.
Formula: NiAs
Constants:
Mol. Wt. 133.60
M. P. 968°C
Density 7.57 @0°C
Toxicity: Highly toxic. See Arsenic Compounds.
Fire Hazard: Moderate, by chemical reaction to form arsine. See also Hydrides (Section 6).
Explosion Hazard: Moderate, by chemical reaction to evolve arsine. See also Hydrides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of Arsenic; it will react with water, steam or acids to produce toxic and flammable vapors; it can react with oxidizing materials.
Storage and Handling: Section 7

NICKEL o-ARSENITE, ACID
Description: Green-white crystals.
Formula: $Ni_3H_6(AsO_3)_4 . H_2O$
Constants:
Mol. Wt. 691.77
M. P. Decomposes
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

NICKEL BENZENE SULFONATE
Description: Green, monoclinic crystals.

Formula: $Ni(C_6H_5SO_3)_2 \cdot 6H_2O$
Constants:
Mol. Wt. 481.11
B. P. Decomposes
Density 1.628 @25°C
Toxicity: See Nickel Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

NICKEL BORIDE

Description: Prisms.
Formula: NiB
Constants:
Mol. Wt. 69.51
Density 7.39 @18°C
Toxicity: See Nickel Compounds and Boron Compounds.
Fire Hazard: See Boron Hydride, which is easily evolved by this material.
Explosion Hazard: See Boron Hydrides.
Disaster Control: Dangerous; it will react with water, steam or acids to produce toxic and flammable vapors.
Storage and Handling: Section 7

NICKEL BROMATE

Description: Monoclinic crystals.
Formula: $Ni(BrO_3)_2 \cdot 6H_2O$
Constants: Mol. Wt. 422.62
M. P. Decomposes
Density 2.575
Toxicity: See Nickel Compounds and Bromates.
Fire Hazard: Moderate, by chemical reaction; a powerful oxidizing agent.
Disaster Control: Dangerous, when heated, it emits toxic fumes of bromine; it can react vigorously on contact with reducing materials.
Storage and Handling: Section 7

NICKEL BROMIDE

Synonym: Nickelous bromide.
Description: Yellowish, brown, deliquescent crystals.
Formula: $NiBr_2$
Constants:
Mol. Wt. 218.52
M. P. 963°C
Density 4.64 @28°C
Toxicity: See Bromides.
Disaster Control: See Bromides.
Storage and Handling: Section 7

NICKEL BROMIDE AMMONIA

Description: Violet powder.
Formula: $NiBr_2 \cdot 6NH_3$
Constants:
Mol. Wt. 320.72
Density 1.837
Toxicity: See Bromides.
Disaster Control: See Bromides.
Storage and Handling: Section 7

NICKEL BROMOPLATINATE

Description: Trigonal crystals.
Formula: $NiPtBr_6 \cdot 6H_2O$
Constants:
Mol. Wt. 841.51
Density 3.715
Toxicity: See Nickel Compounds and Platinum Compounds.
Disaster Control: Dangerous, when heated to decomposition, it emits toxic fumes of bromine.
Storage and Handling: Section 7

NICKEL CARBIDE

Description: Powder.
Formula: Ni_3C
Constants:
Mol. Wt. 188.08
Density 7.957 @25°C
Toxicity: See Nickel Compounds.
Fire Hazard: See Carbides.
Explosion Hazard: See Carbides.

NICKEL CARBONATE

Description: Rhombic, light green crystals.
Formula: $NiCO_3$
Constants:
Mol. Wt. 118.70
M. P. Decomposes
Toxicity: See Nickel Compounds.

NICKEL CARBONYL

Description: Colorless, volatile liquid or needles.
Formula: $Ni(CO)_4$
Constants:
Mol. Wt. 170.69
M. P. −25°C
B. P. 43°C
Density 1.3185 @17°C
Vap. Press. 400 mm @25.8°C
Toxic Hazard Rating:
Acute Local: Inhalation 3

Acute Systemic: Inhalation 3
Chronic Local: U
Chronic Systemic: 3
MAC: AGGIH (accepted): One part per million in air; 7 milligrams per cubic meter of air.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 2% (L. E. L.) @ 20° C
Disaster Control: Dangerous; when heated or on contact with acid or acid fumes, it emits highly toxic fumes; it can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

NICKEL CHLORATE

Description: Dark red crystals.
Formula: $Ni(ClO_3)_2 . 6H_2O$
Constants:
Mol. Wt. 333.70
M. P. Decomp. @80°C
Density 2.07
Toxicity: See Nickel Compounds and Chlorates.
Fire Hazard: See Chlorates.
Explosion Hazard: See Chlorates.
Disaster Control: See Chlorates.
Storage and Handling: Section 7

NICKEL CHLORIDE

Description: A: Yellow, deliquescent scales B: Monoclinic, green crystals.
Formula: A: $NiCl_2$ B: $NiCl_2 \cdot 6H_2O$
Constants:
Mol. Wt. A: 129.60 B: 237.70
M. P. Sublimes (A)
B. P. 987°C (A)
Density 3.55 (A)
Vap. Press. 1 mm @671°C
Toxicity: See Nickel Compounds.
Disaster Control: See Chlorides.
Storage and Handling: Section 7

NICKEL CHLOROPALLADATE

Description: Hexagonal crystals.
Formula: $NiPdCl_6 . 6H_2O$
Constants:
Mol. Wt. 486.23
Density 2.353
Toxicity: See Nickel Compounds and Palladium Compounds.
Disaster Control: See Chlorides.
Storage and Handling: Section 7

NICKEL CHLOROPLATINATE

Description: Trigonal crystals.
Formula: $NiPtCl_6 \cdot 6H_2O$
Constants: Mol. Wt. 574.76
Density 2.798
Toxicity: See Platinum Compounds and Nickel Compounds.
Disaster Control: See Chlorids.
Storage and Handling: Section 7

NICKEL COBALT SULFATE

Description: Reddish-brown, crystalline mass.
Formula: $NiSO_4 \cdot CoSO_4 \cdot 14H_2O$
Constant:
Mol. Wt. 561.99
Toxicity: See Nickel Compounds and Cobalt Compounds.

NICKEL COMPOUNDS

Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1; Ingestion 1; Inhalation 1
Acute Systemic: Ingestion 1; Inhalation 1
Chronic Local: Irritant 2; Allergen 1
Chronic Systemic: Inhalation 2
Toxicology: Nickel and most salts of nickel are not generally considered to cause systemic poisoning. Ingestion of large doses of nickel, as a nickel compound, (1 to 3 mg per kg of weight) has been shown to cause intestinal disorders, convulsions and asphyxia in dogs. Nickel has been found in the hair of persons exposed to nickel oxide dust, but no systemic effects which could be attributed to nickel alone have been reported. in 1938, the British described 10 cases of lung cancer and numerous cases of

cancer of the nose and nasopharynx occuring in workers in a nickel refinery. The exact cause of the malignancies was never completely explained but arsenic was involved. The most common effect resulting from exposure to nickel compounds is the development of "nickel itch." This form of dermatitis occurs chiefly in persons doing nickel-plating. There is marked variation in individual susceptibility to the dermatitis. It occurs more frequently under conditions of high temperature and humidity when the skin is moist, and chiefly affects the hands and arms (Section 9). Nickel carbonyl is highly irritating to the lungs and also can produce asphyxia by decomposing with the formation of carbon monoxide.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3

NICKEL CYANIDE

Description: Apple-green plates or powder.
Formula: $Ni(CN)_2$
Constant: Mol. Wt. 110.73
Toxicity: Highly Toxic. See Cyanides.
Fire Hazard: See Cyanides.
Explosion Hazard: See Cyanides.
Disaster Control: See Cyanides.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

NICKEL DI-n-BUTYLDITHIOCARBAMATE

Description: Dark olive-green powder.
Formula: $Ni[(C_4H_9)_2NCSS]_2$
Constants: Mol. Wt. 467.44
M. P. 89 - 90°C
Density 1.29
Toxicity: See Nickel Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

NICKEL DITHIONATE

Description: Green, triclinic crystals.
Formula: $NiS_2O_6 \cdot 6H_2O$
Constants:
Mol. Wt. 326.92
M. P. Decomposes
Density 1.908
Toxicity: See Nickel Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

NICKEL FERROCYANIDE

Description: Green-white crystals.
Formula: $Ni_2Fe(CN)_6 \cdot xH_2O$
Constant:
Density 1.892
Toxicity: Moderate. See Ferrocyanides and Nickel Compounds.
Disaster Control: See Ferrocyanides.
Storage and Handling: Section 7

NICKEL FLUOGALLATE

Description: Pale green crystals.
Formula: $[Ni(H_2O)_6][GaF_5H_2O]$
Constants:
Mol. Wt. 349.52
M. P. $-5H_2O$ @110°C
Density 2.45
Toxicity: See Fluogallates and Nickel Compounds.
Disaster Control: See Fluogallates.
Storage and Handling: Section 7

NICKEL FLUORIDE

Description: Green crystals.
Formula: NiF_2
Constants:
Mol. Wt. 96.69
Density 4.63
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

NICKEL FORMATE

Description: Green crystals.
Formula: $Ni(CHO_2)_2 \cdot 2H_2O$
Constants:
Mol. Wt. 184.76
M. P. Decomposes
Density 2.154
Toxicity: See Nickel Compounds.

Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

NICKEL HYDROXIDE
Synonym: Nickelic hydroxide.
Description: Black, amorphous powder.
Formula: $Ni(OH)_3$
Constant:
Mol. Wt. 109.71
Toxicity: See Nickel Compounds.

NICKEL HYPOPHOSPHITE
Description: Green crystals.
Formula: $Ni(H_2PO_2)_2 \cdot 6H_2O$
Constants:
Mol. Wt. 296.78
M. P. Decomposes @100°C
Density 1.82 @19.8°C
Toxicity: See Nickel Compounds.
Explosion Hazard: Moderate, when exposed to heat.
Explosive Range: @100°C
Disaster Control: Dangerous; may explode at 100°C. Keep away from heat and open flame.
Storage and Handling: Section 7

NICKEL IODATE
Description: Yellow needles.
Formula: $Ni(IO_3)_2$
Constants:
Mol. Wt. 408.53
Density 5.07
Toxicity: See Nickel Compounds and Iodates.
Fire Hazard: See Iodates.
Disaster Control: See Iodates.
Storage and Handling: Section 7

NICKEL IODIDE
Description: Black, deliquescent crystals.
Formula: NiI_2
Constants:
Mol. Wt. 312.53
M. P. 797°C
Density 5.834
Toxicity: See Nickel Compounds and Iodides.
Disaster Control: See Iodides.
Storage and Handling: Section 7

NICKEL MONOSULFIDE
Synonym: Millerite.
Description: Trigonal or amorphous, black crystals.
Formula: NiS
Constants:
Mol. Wt. 90.76
M. P. 797°C
Density 5.3 - 5.65
Toxicity: See Sulfides and Nickel Compounds.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

NICKEL MONOXIDE
Synonym: Bunsenite.
Description: Cubic, green-black crystals.
Formula: NiO
Constants:
Mol. Wt. 74.69
M. P. 1990°C
Density 7.45
Toxicity: See Nickel Compounds.

NICKEL NITRATE
Description: Green, deliquescent crystals.
Formula: $Ni(NO_3)_2 \cdot 6H_2O$
Constants: Mol. Wt. 290.8
M. P. 56.7°C
B. P. 136.7°C
Density 2.05
Toxicity: See Nickel Compounds and Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

NICKEL OLEATE
Description: Green oil.
Formula: $Ni(C_{18}H_{33}O_2)_2$
Constants:
Mol. Wt. 621.58
M. P. 18 - 20°C
Toxicity: See Nickel Compounds.

NICKELOUS HYDROXIDE
Synonym: Nickel hydroxide.
Description: Light green crystals or amorphous.
Formula: $Ni(OH)_2$
Constants:
Mol. Wt. 92.7
Density 4.1
Toxicity: See Nickel Compounds.

NICKELOUS, NICKELIC SULFIDE
Synonym: Polydymite.
Description: Cubic, gray-black crystals.
Formula: Ni_3S_4

Constants:
Mol. Wt. 304.33
Density 4.7
Toxicity: See Nickel Compounds.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

NICKEL OXALATE
Description: Light green powder.
Formula: $NiC_2O_4 \cdot 2H_2O$
Constant:
Mol. Wt. 182.74
Toxicity: Highly toxic. See Oxalates.
Disaster Control: Dangerous; when heated it emits toxic fumes (Section 6).
Storage and Handling: Section 7

NICKEL OXIDE. See Nickel Monoxide.

NICKEL PERCHLORATE
Description: Hexagonal, green needles.
Formula: $Ni(ClO_4)_2 \cdot 6H_2O$
Constants:
Mol. Wt. 365.70
M. P. 140°C
Toxicity: See Nickel Compounds and Perchlorates.
Fire Hazard: See Perchlorates.
Explosion Hazard: See Perchlorates.
Disaster Control: See Perchlorates.
Storage and Handling: Section 7

NICKEL PEROXIDE
Synonym: Nickelic oxide.
Description: Gray-black powder.
Formula: Ni_2O_3
Constants:
Mol. Wt. 165.38
M. P. $-O_2$ @600°C
Density 4.83
Toxicity: See Nickel Compounds.
Fire Hazard: See Peroxides.
Storage and Handling: Section 7

NICKEL PHOSPHATE
Synonym: Nickelous phosphate.
Description: Apple-green plates or emerald crystals or granules.
Formula: $Ni_3(PO_4)_2 \cdot 8H_2O$
Constants:
Mol. Wt. 510.24
M. P. Decomposes
Toxicity: See Nickel Compounds.

NICKEL POTASSIUM SULFATE
Description: Blue-green crystals.
Formula: $NiSO_4 \cdot K_2SO_4 \cdot 6H_2O$
Constants:
Mol. Wt. 437.10
M. P. Decomp. @less than 100°C
Density 2.124
Toxicity: See Nickel Compounds.

NICKEL SELENATE
Description: Green, tetragonal, monoclinic crystals.
Formula: $NiSeO_4 \cdot 6H_2O$
Constants:
Mol. Wt. 341.75
Density 2.314
Toxicity: See Selenium Compounds and Nickel Compounds.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

NICKEL SELENIDE
Description: Cubic, white or gray crystals.
Formula: NiSe
Constants:
Mol. Wt. 137.65
Density 8.46
Toxicity: See Selenium Compounds and Nickel Compounds.
Fire Hazard: Dangerous; it can easily evolve hydrogen selenide, which is highly flammable.
Explosion Hazard: Slight; it can evolve hydrogen selenide. See also Hydrides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of selenium; will react with water, steam or acids to produce toxic and flammable vapors.
Storage and Handling: Section 7

NICKEL SUBSULFIDE
Synonym: Heazlewoodite.
Description: Pale yellowish, bronze metallic, lustrous crystals.
Formula: Ni_3S_2
Constants:
Mol. Wt. 240.19
Density 5.82
Toxicity: See Sulfides and Nickel Compounds.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

NICKEL SULFATE
Description: Cubic, yellow crystals.
Formula: $NiSO_4$
Constants:
Mol. Wt. 154.76
M. P. $-SO_3$ @ 840°C
Density 3.68
Toxicity: See Nickel Compounds.
Storage and Handling: Section 7

NICKEL SULFATE, ANHYDROUS. See Nickel Sulfate.

NICKEL SULFITE
Description: Tetrahagonal, green crystals.
Formula: $NiSO_3 \cdot 6H_2O$
Constant:
Mol. Wt. 246.85
Toxicity: See Nickel Compounds and Sulfites.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

NICOTINE
Synonym: β-Pyridyl-α-methyl pyrrolidine.
Description: In its pure state, a colorless and almost odorless oil; sharp burning taste; alkaloid tobacco.
Formula: $C_{10}H_{14}N_2$
Constants:
Mol. Wt. 162.23
M. P. Below −80°C
B. P. 247.3°C
Density 1.0092 @ 20°C
Autoign. Temp. 471°F
Vap. Press. 1 mm @ 61.8°C
Vap. D. 5.61
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 0.75 - 4.0%
Disaster Control: Dangerous; when heated, emits highly toxic fumes; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

NICOTINE CUPROCYANIDE
Toxicity: See Nicotine and Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

NICOTINE HYDROCHLORIDE. See Nicotine.
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

NICOTINE SALICYLATE. See Nicotine.
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

NICOTINE SULFATE. See Nicotine.
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

NICOTINE TARTRATE. See Nicotine.
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

NIOBIUM
Synonym: Columbium.
Description: Rhombic, steel-gray, lustrous, metallic crystals.
Formula: Nb
Constants:
At. Wt. 92.91

M. P. 1950°C
B. P. 2900°C
Density 8.55
Toxicity: Unknown
Radiation Hazard: Artificial isotope Nb^{95}, half-life: 35 days; emits beta particles of 0.15 mev and gamma rays of 0.24 and 0.77 mev. The permissible levels are: In body: 90 microcuries; in air: 4×10^{-7} microcurie per milliliter; in water: 4×10^{-3} microcurie per milliliter. Hazard Rating, Class II (National Bureau of Standards Handbook No. 42).
Fire Hazard: Moderate, in the form of dust, when exposed to flame or by chemical reaction; can react with oxidizing materials. See also Powdered Metals (Section 6).
Explosion Hazard: Slight, in the form of dust, when exposed to flame.
Storage and Handling: Section 7

NIOBIUM CARBIDE
Description: Cubic, black or lavender-gray powder.
Formula: NbC
Constants:
Mol. Wt. 104.91
M. P. Approx. 3900°C
Density 7.82
Toxicity: Details unknown. See also Carbides.

NIOBIUM CHLORIDE
Synonym: Niobium pentachloride.
Description: Yellow-white deliquescent powder.
Formula: $NbCl_5$
Constants:
Mol. Wt. 270.20
M. P. 194°C
B. P. 241°C
Toxicity: Irritant. See Hydrochloric Acid.
Disaster Control: Dangerous; on heating it may evolve toxic and corrosive fumes of hydrochloric acid.
Storage and Handling: Section 7

NIOBIUM HYDRIDE
Description: Gray powder.
Formula: NbH
Constants:
Mol. Wt. 93.92
M. P. Infusible
Density 6.6
Toxicity: Details unknown. See also Hydrides.
Fire Hazard: See Hydrides.
Explosion Hazard: See Hydrides.
Disaster Control: See Hydrides.

NIOBIUM HYDROGEN OXALATE
Description: Monoclinic, colorless crystals.
Formula: $Nb(HC_2O_4)_5$
Constant:
Mol. Wt. 538.05
Toxicity: Highly toxic. See Oxalates.
Fire Hazard: Slight; when heated, it emits toxic fumes (Section 6).
Storage and Handling: Section 7

NIOBIUM NITRIDE
Description: Cubic, black crystals.
Formula: NbN
Constants:
Mol. Wt. 106.92
M. P. 2573°C
Density 8.4
Toxicity: Unknown

NIOBIUM OXYBROMIDE
Description: Yellow crystals.
Formula: $NbOBr_3$
Constants:
Mol. Wt. 348.66
M. P. Sublimes
Toxicity: Details unknown. See also Bromides.
Disaster Control: Dangerous; on decomposition it emits toxic fumes of bromides.
Storage and Handling: Section 7

NIOBIUM PENTAFLUORIDE
Description: Colorless, monoclinic prisms.
Formula: NbF_5
Constants:
Mol. Wt. 187.91
M. P. 72°C
B. P. 220°C (approx.)
Density 3.92
Toxicity: Highly toxic. See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

NIRVANOL
Synonym: Phenylethylhydantoin.
Description: Colorless, odorless,

crystalline powder.
Formula:
(NHCO)(CONH)C(C_2H_5)(C_6H_5)
Constants:
Mol. Wt. 204.17
M. P. 199 - 200°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits toxic fumes (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

NITER. See Potassium Nitrate.

NITRAMON. See Explosives, High.

NITRATE OF ALUMINUM. See Aluminum Nitrate.
Shipping Regulations: Section 11.
Coast Guard Classification: Oxidizing material.

NITRATES, N.O.S.
Description: Organic nitrates are usually termed nitro compounds. These compounds are a combination of the nitro ($^-NO_2$) group and an organic radical. However, this term is often used to denote nitric acid esters of an organic material. Inorganic nitrates are compounds of metals which are combined with the mono-valent $^-NO_3$ radical.
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
Toxicology: Large amounts taken by mouth may have serious or even fatal effects. The symptoms are dizziness, abdominal cramps, vomiting, bloody diarrhea, weakness, convulsions and collapse. Small, repeated doses may lead to weakness, general depression, headache and mental impairment.
Fire Hazard: Moderate, by spontaneous chemical reaction; practically all nitrates are powerful oxidizing agents (Section 6).
Explosion Hazard: Nitrates may explode when shocked, exposed to heat or flame or by spontaneous chemical reaction (See also Explosives, High). All the inorganic nitrates act as oxygen carriers; under proper conditions these can give up their oxygen to other materials, which may in turn detonate. For example, potassium or barium nitrate are added to double-base powders for the purpose of reducing flash and rendering the powder more ignitable. A further use for these materials is to mix them with a smokeless powder which is not completely colloided, for the purpose of granulation. An example of such a powder is "E. C. Powder", used for loading blank cartridges and hand grenades. Sodium and potassium nitrate are also used in black powder as the oxygen carrier to support the combustion of the sulfur and the charcoal.

Ammonium nitrate has all the properties of the other nitrates, but is also able to detonate by itself under certain conditions. It is therefore a high explosive, although very insensitive to impact and difficult to detonate. In the pure state, it requires a combination of an initiator and a high explosive. This combination is known as a reinforced detonator. Ammonium nitrate in combination with nitro compounds (such, perhaps, as trinitrotoluene) forms one of the major high explosives for military use. Ammonium nitrate is widely used also as the chief component of "ammonia permissibles," and of "ammonia dynamites"; as a component of many pyrotechnic mixtures; and in combination with smokeless powder, as a granular blasting explosive. It is a relatively safe high explosive which, however, must be stored in a cool, ventilated place, away from acute fire hazards and easily oxidized materials. Ammonium nitrate must not be confined, because if a fire should start, confinement can cause detonation with extremely violent results.

Disaster Control: Dangerous, due to fire and explosion hazard. On decomposition they emit toxic fumes. They are powerful oxidizing agents which may cause violent reaction with reducing materials. Nitrates should be protected carefully as discussed in detail in Section 7.

Ventilation Control (use normal rate): Section 2

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations: Section 11.
- I. C. C. Classification: Oxidizing material; yellow label.
- Coast Guard Classification: Oxidizing material.

NITRATING (MIXED) ACID. See Nitric Acid and Sulfuric Acid.

Shipping Regulations: Section 11.
- I. C. C. Classification: Corrosive liquid; white label.
- Coast Guard Classification: Corrosive liquid; white label.

NITRIC ACID

Synonyms: Aqua fortis; hydrogen nitrate; azotic acid.

Description: Transparent colorless or yellowish, fuming suffocating caustic and corrosive liquid.

Formula: HNO_3

Constants:
- Mol. Wt. 63.02
- M. P. −42°C
- B. P. 86°C
- Density 1.502

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: Inhalation 3
- Chronic Local: Irritant 2
- Chronic Systemic: U

Toxicology: The exact composition of the "fumes" or vapor produced by nitric acid depends upon such factors as temperature, humidity, and whether or not the acid comes in contact with other materials such as heavy metals or organic compounds. Depending upon these factors, the vapor will consist of a mixture of the various oxides of nitrogen and of nitric acid vapor. Nitric acid vapor is highly irritant to the mucous membranes of the eyes and respiratory tract and to the skin. It is corrosive to the teeth. Because of its irritant properties, chronic exposure to dangerous concentrations of the acid vapor seldom occur.

Fire Hazard: Moderate, by chemical reaction with reducing agents. It is a powerful oxidizing agent.

To Fight Fire: Water (Section 6).

Explosion Hazard: Slight, by chemical reaction to evolve oxides of nitrogen; can explode on contact with powerful reducing agents.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen and hydrogen nitrate; will react with water or steam to produce heat and toxic and corrosive fumes.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

Shipping Regulations: Section 11.
- I.C.C. Classification: Corrosive liquid; white label.
- Coast Guard Classification: Corrosive liquid; white label.

NITRIC ACID, FUMING

Synonym: Nitric acid, anhydrous.

Description: Colorless to yellow to red corrosive liquid.

Formula: $HNO_3 + N_2O_5$

Constant:
- Density Above 1.480

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: Inhalation 3
- Chronic Local: Irritant 2
- Chronic Systemic: Inhalation 3

Fire Hazard: Dangerous; very powerful oxidizing agent (Section 6).

Explosion Hazard: Moderate; can react explosively with many reducing agents.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; will react with water or steam to produce heat and toxic, corrosive and flammable vapors.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

NITRIC OXIDE

Description: Colorless gas; blue liquid and solid.

Formula: NO

Constants:

Mol. Wt. 30.01

M. P. -161°C

B. P. -151.8°C

Density 1.3402 g/liter; liquid: 1.269 @ -150°C

Toxic Hazard Rating:

Acute Local: Irritant 3; Inhalation 3

Acute Systemic: Inhalation 3

Chronic Local: U

Chronic Systemic: Inhalation 2

MAC: ACGIH (accepted); 25 parts per million in air; 31 milligrams per cubic meter of air.

Toxicology: Exposure to nitrous fumes may occur whenever nitric acid acts upon organic material, such as wood, sawdust and refuse; it occurs when nitric acid is heated, and when organic nitro compounds are burned, as for example, celluloid, cellulose nitrate (guncotton) and dynamite. The action of nitric acid upon metals, as in metal etching and pickling, also liberates the fumes. In high-temperature welding, as with the oxyacetylene or electric torch, the nitrogen and oxygen of the air unite to form oxides of nitrogen. Exposure may also occur in many manufacturing processes when nitric acid is made or used.

The oxides of nitrogen are somewhat soluble in water, reacting with it in the presence of oxygen to form nitric and nitrous acids. This is the action that takes place deep in the respiratory system. The acids formed are irritants, causing congestion of the throat and bronchi, and edema of the lungs. The acids are neutralized by the alkalis present in the tissues, with the formation of nitrates and nitrites. The latter may cause some arterial dilatation, fall in blood pressure, headache and dizziness, and there may be some formation of methemoglobin. However, the nitrite effect is of secondary importance.

Because of their relatively low solubility in water, the nitrogen oxides are only slightly irritating to the mucous membranes of the upper respiratory tract. Their warning power is therefore low, and dangerous amounts of the fumes may be breathed before the workman notices any real discomfort. Higher concentrations (60 to 150 ppm) cause immediate irritation of the nose and throat, with coughing and burning in the throat and chest. These symptoms often clear up on breathing fresh air, and the workman may feel well for several hours. Some 6 to 24 hours after exposure, he develops a sensation of tightness and burning in the chest, shortness of breath, sleeplessness and restlessness. Dyspnea and air hunger may increase rapidly, with development of cyanosis and loss of consciousness, followed by death. In cases which recover from the pulmonary edema, there is usually no permanent disability, but pneumonia may develop later. Concentrations of 100 to 150 ppm are dangerous for short exposures of 30 to 60 minutes. Concentrations of 200 to 700 ppm may be fatal after even very short exposures.

Continued exposure to low concentrations of the fumes, insufficient to cause pulmonary edema, is said to result in chronic irritation of the respiratory tract, with cough, headache, loss of appetite, dyspepsia, corrosion of the teeth and gradual loss of strength.

Exposure to nitrous fumes is always potentially serious, and persons so exposed should be kept under close observation for at least 48 hours.

Disaster Control: Dangerous; shock can shatter the compressed gas container with explosive force; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; will react with water or steam to produce heat and corrosive fumes; can react vigorously with reducing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

NITRIDES
Description: Compounds of $N^{\equiv}$ as the anion, such as Li_3N, Ca_3N_2, etc.
Toxicity: The details of toxicity of nitrides as a group is unknown. However, many nitrides react with moisture to evolve ammonia. This gas is an irritant to the nose, throat and eyes. See Ammonia.
Fire Hazard: To the extent that many nitrides evolve flammable ammonia gas upon contact with moisture, nitrides can be fire hazards. See Ammonia.
Explosion Hazard: Moderate. See Ammonia.
Disaster Control: Moderately dangerous due to fire and explosion hazard. On decomposition they emit toxic fumes of ammonia.

NITRITES
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: Ingestion 1; Inhalation 1
Toxicology: Large amounts taken by mouth may produce nausea, vomiting, cyanosis (due to methemoglobin formation) collapse and coma. Repeated small doses cause a fall in blood pressure, rapid pulse, headache and visual disturbances.
Fire Hazard: Details unknown. They are generally powerful oxidizers. In contact with readily oxidized materials, a violent reaction such as a fire or explosion may ensue.
Explosion Hazard: Details unknown. Organic nitrites may decompose violently.
Disaster Control: Dangerous; shock may explode them; when heated to decomposition, they emit highly toxic fumes of oxides of nitrogen; can react vigorously with reducing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

p-NITROACETANILIDE
Description: White crystals.
Formula: $CH_3CONHC_6H_4NO_2$
Constants:
  Mol. Wt. 180.16
  M. P. 215°C
Toxicity: Details unknown. See also Acetanilide and Nitro Compounds of Aromatic Hydrocarbons.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react with oxidizing materials.
Storage and Handling: Section 7

5-NITRO-2-AMINOANISOLE. See 4-Nitro-o-Anisidine.

m-NITROANILINE
Synonym: n-Nitraniline.
Description: Yellow crystals.
Formula: $C_6H_6N_2O_2$
Constants:
  Mol. Wt. 138.1
  M. P. 114°C
  B. P. 305.7°C
  Density 1.43
  Vap. Press. 1 mm @119.3°C
Toxicity: Highly toxic. See p-Nitroaniline.
Fire Hazard: Moderate, when exposed to heat or flame or by chemical reaction with oxidizers. Causes nitration of materials which can then ignite spontaneously.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

o-NITROANILINE
Synonym: o-Nitraniline.
Description: Orange-yellow crystals.
Formula: $C_6H_6N_2O_2$
Constants:
  Mol. Wt. 138.1
  M. P. 71 - 72°C
  B. P. 284.5°C
  Density 1.442
  Vap. Press. 1 mm @104.0°C
Toxicity: Highly toxic. See p-Nitroaniline.
Fire Hazard: See Nitrates.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

p-NITROANILINE
Synonym: 1-Amino-4-nitrobenzene.
Description: Yellow crystals.
Formula: $C_6H_6N_2O_2$
Constants:
  Mol. Wt. 138.1
  M. P. 146.5°C
  B. P. 336.0°C
  Flash P. 390°F (C.C.)
  Density 1.437
  Vap. Press. 1 mm @142.4
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
  Chronic Local: U
  Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
MAC: ACGIH (tentative); 1 part per million in air.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.

4-NITRO-o-ANISIDINE
Synonyms: 5-Nitro-2-aminoanisole; 2-methoxy-4-nitroaniline.
Description: Brown, crystalline mass.
Formula: $(NO_2)(NH_2)C_6H_3OCH_3$
Constants:
  Mol. Wt. 168
Toxicity: Details unknown. See also p-Nitroaniline and Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

NITROBENZENE
Synonyms: Oil of mirbane; nitrobenzol.
Description: Bright yellow crystals or yellow, oily liquid.
Formula: $C_6H_5NO_2$
Constants:
  Mol. Wt. 123.11
  M. P. 5.7°C
  B. P. 210.9°C
  Flash P. 190°F (C.C.)
  Density 1.19867 @25°/4°C
  Autoign. Temp. 900°F
  Vap. Press. 1 mm @44.4°C
  Vap. D. 4.25
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
  Chronic Local: U
  Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
MAC: ACGIH (accepted); 1 part per million in air; 5 milligrams per cubic meter of air.
Fire Hazard: Moderate, when exposed to heat or flame.
Underwriters Laboratory Classification: 20 - 30.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 1.8% @200°F.
Disaster Control: See Nitrates.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.

m-NITROBENZENE SULFONYL FLUORIDE

Description: Yellow solid.
Formula: $O_2NC_6H_4SO_2F$
Constants:
Mol. Wt. 205
M. P. 45 - 47°C
B. P. 143°C @7 mm
Flash P. 335°F
Density 1.582
Vap. Press. 5 mm @130°C
Vap. D. 7.07
Toxicity: Apparently low acute inhalation toxicity to test animals. Possibly slightly irritating to skin.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides, oxides of sulfur; can react with oxidizing materials.
Storage and Handling: Section 7

p-NITROBENZOIC ACID

Description: Crystals.
Formula: $NO_2C_6H_4COOH$
Constants:
Mol. Wt. 167.1
M. P. 242.4°C
B. P. Sublimes
Density 1.550 @32°/4°C
Toxicity: Unknown
Disaster Control: See Nitrates.
Storage and Handling: Section 7

p-NITROBENZOIC ACID ETHYL ESTER

Synonym: Ethyl p-nitrobenzoate.
Toxicity: Details unknown; larvicide for European corn borer.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

m-NITROBENZOTRIFLUORIDE

Synonym: m-Nitrotrifluoromethyl benzene.
Description: Thin, pale straw, oily liquid with aromatic odor.
Formula: $C_7H_4F_3NO_2$
Constants: Mol. Wt. 191.1
M. P. -5°C
B. P. 202.8°C
Flash P. 217°F (O.C.)
Density 1.437 @15.5°/15.5°C
Vap. Press. 0.3 mm @25°C
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen and fluorides.
Storage and Handling: Section 7

m-NITROBENZOYL CHLORIDE

Description: Yellow to brown liquid, partially crystallized at room temperature.
Formula: $NO_2C_6H_4COCl$
Constants: Mol. Wt. 185.5
M. P. 28 - 31°C
B. P. 278°C
Vap. D. 6.43
Toxicity: Details unknown. See also Hydrochloric Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of nitrogen; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

p-NITROBENZOYL CHLORIDE

Description: Yellow, crystalline solid.
Formula: $NO_2C_6H_4COCl$
Constants: Mol. Wt. 185.5
M. P. 70°C
B. P. 154°C @15 mm
Toxicity: Details unknown. See also Hydrochloric Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of nitrogen; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

o-NITROBENZYL CHLORIDE

Description: Crystals.
Formula: $NO_2C_6H_4CH_2Cl$
Constants:
Mol. Wt. 171.59
M. P. 48 - 49°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits

highly toxic fumes of chlorides and oxides of nitrogen.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

o-NITROBIPHENYL
Synonyms: ONB; o-nitrodiphenyl.
Description: Light yellow to reddish-colored liquid or crystalline solid.
Formula: $C_6H_5C_6H_4NO_2$
Constants:
  Mol. Wt. 199.2
  M. P. 35°C
  B. P. 330°C
  Flash P. 290°F
  Density 1.189 @40°/15.5°C
  Autoign Temp. 179°C
  Vap. Press. 2 mm @140°C
  Vap. D. 6.9
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: See Nitrates.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

1-NITROBUTANE
Description: Liquid.
Formula: $C_4H_9NO_2$
Constants: Mol. Wt. 103.12
  B. P. 151°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride.
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-NITROBUTANE
Description: Liquid.
Formula: $C_4H_9NO_2$
Constants: Mol. Wt. 103.1
  B. P. 139°C
Toxicity: See 1-Nitrobutane.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride.
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

2-NITRO-1-BUTANOL
Description: Colorless liquid.
Formula: $CH_3CH_2CH(NO_2)CH_2OH$
Constants: Mol. Wt. 119.12
  M. P. -47°C
  B. P. 105°C
  Density 1.133 @20°/20°C
Toxicity: Details unknown. See also Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: See Nitrates.
Storage and Handling: Section 7

NITRO CARBONITRATE
Description: A solid explosive.
Composition: A mixture of ammonium nitrate, dinitro cotton, etc.
Toxicity: Unknown.
Fire Hazard: Moderate; an oxidizing agent. See Nitrates.
Explosion Hazard: See Explosives, High; Nitrates.
Disaster Control: See Explosives, High; Nitrates.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Oxidizing material; yellow label.
  Coast Guard Classification: Oxidizing material.

NITROCELLULOSE
Synonym: Cellulose nitrate; cellulose hexanitrate; cellulose pentanitrate; cellulose tetranitrate;

cellulose trinitrate; guncotton; nitrocotton.
Description: Dry: White, amorphous powder or cotton-like solid; Wet: Water-white liquid.
Formula: $C_{12}H_{14}(ONO_2)_6O_4$ to $C_{12}H_{17}(ONO_2)_3O_7$
Constants:
Mol. Wt. 594.28 to 459.28
M. P. Ignites @160 - 170°C
Density 1.66
Flash P. 40°F (C.C.)
Fire Hazard: Highly dangerous in the dry state, when exposed to heat, flame or powerful oxidizers. When wet with 35% of denatured ethyl alcohol it is about as hazardous as ethyl alcohol alone or gasoline.

Dry nitrocellulose burns rapidly, with intense heat and ignites very easily (Section 6).
Explosion Hazard: Moderately dangerous. See Explosives.
To Fight Fire: Use copious volumes of water, Carbon dioxide is effective in extinguishing fires of nitrocellulose solvents.
Disaster Control: The dry material is highly dangerous; the wet, somewhat less so. Keep away from heat and open flame!
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable liquid; red label (for wet product).

o-NITROCHLORBENZENE, LIQUID.

See Nitrochlorobenzene.
Shipping Regulations: Section 11.
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

p-NITROCHLOROBENZENE

Synonym: p-Nitrochlorbenzol.
Description: Liquid.
Formula: $ClC_6H_4NO_2$
Constants:
Mol. Wt. 157.6
M. P. 83°C
B. P. 242°C
Flash P. 261°F (C.C.)
Density 1.368 @22°/4°C
Vap. D. 5.43
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen and chlorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Meta or Para - Solid (I.C.C. and Coast Guard);
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

3-NITRO-4-CHLOROBENZOTRIFLUORIDE

Description: Thin, yellow, oily liquid.
Formula: $C_6H_3CF_3(NO_2)(Cl)$
Constants:
Mol. Wt. 225.6
M. P. -7.5°C
B. P. 222°C
Density 1.542 @15.5°/15.5°C
Toxicity: Details unknown. See also Nitro Compounds or Aromatic Hydrocarbons.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides, chlorides and oxides of nitrogen.
Storage and Handling: Section 7

NITROCHLOROFORM. See Chloropicrin.

NITROCHLOROMETHANE. See Chloropicrin.

NITRO COMPOUNDS OF AROMATIC HYDROCARBONS

Toxic Hazard Rating:
- Acute Local: Irritant 1
- Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
- Chronic Local: U
- Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3

Toxicology: The di- and trinitrobenzenes, like the mononitrobenzene, are absorbed chiefly through the skin and through inhalation of the dust or vapor when these materials are heated. The dinitrobenzenes are believed to be somewhat more toxic than the mononitrobenzene, and more toxic than aniline. The effect of di- and trinitrobenzene on the body is similar to that of aniline and mononitrobenzene, with reduction of the oxygen-carrying power of the blood and depression of the nervous system being responsible for most of the symptoms following acute exposure. Poisoning with the solid nitro compounds is usually slower and less severe, than is the case with the liquid nitro and amino benzenes since absorption is less rapid. Thus, chronic poisoning occurs more frequently than acute, the picture in the chronic form being one of anemia, moderate cyanosis, fatigue, slight dizziness, headache, insomnia and loss of weight. The urine is frequently dark in color; the skin on the exposed parts is often yellowish-brown, and the hair yellowish-red. There may be irritation of the nose and throat, nausea and vomiting, sclerotic icterus, and complaints related to the nervous system. Prolonged chronic exposure may result in damage to the liver and kidneys, with production of acute yellow atrophy, toxic hepatitis, and fatty degeneration of the kidneys.

The introduction of one or more chlorine atoms into the nitrobenzene ring results in the formation of chloro-nitrobenzene compounds or nitrochlors. The chloro-mononitrobenzenes have essentially the same toxic effect as nitrobenzene. The chlorine derivatives of dinitrobenzene, on the other hand, while resembling dinitrobenzene in their system effect, are much more irritating to the skin. They act as direct irritants, and in addition may cause sensitivity. For further information see specific nitro compounds.

NITROCOTTON. See Cellulose Nitrate.

NITROCRESOL METHYL ETHER

Description: Pale yellow crystals.
Formula: $C_6H_3CH_3NO_2OCH_3$
Constants:
- Mol. Wt. 167.2
- M. P. 8.5°C
- B. P. 274°C

Toxicity: Details unknown; probably toxic. See also Ethers.
Fire Hazard: Details unknown. See Ethers and Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

NITROCYCLOHEXANE

Description: Straw-colored to water-white mobile liquid; mild odor.
Formula: $O_2NCH(CH_2)_5$
Constants:
- Mol. Wt. 129.2
- B. P. 205.5°C Decomposes
- Freezing P. -35.7°C
- Flash P. 190.4°F (T.O.C.)
- Density 1.06656 @25°C
- Vap. Press. 0.5 mm @25°C
- Vap. D. 4.46

Toxicity: Details unknown. See also Cyclohexane.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

8-NITRO-1-DIAZO-2-NAPHTHOL-4-SULFONIC ACID

Description: Yellow solid.
Formula: $C_{10}H_5N_3SO_6$
Constant:
- Mol. Wt. 295.22

Toxicity: Unknown
Fire Hazard: See Nitrates.

Disaster Control: See Nitrates.
Storage and Handling: Section 7

o-NITRODIPHENYL. See o-Nitrobiphenyl.

2-NITRODIPHENYLAMINE
Description: Crystals.
Formula: $O_2NC_6H_4NHC_6H_5$
Constants:
Mol. Wt. 214.22
M. P. 74.7°C
B. P. 223°C @20 mm
Density 1.366
Toxicity: Details unknown. See Nitro Compounds of Aromatic Hydrocarbons.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

4-NITRODIPHENYLAMINE
Description: White solid.
Formula: $C_6H_5NHC_6H_4NO_2$
Constant:
Mol. Wt. 214.2
Toxicity: Details unknown. See Nitro Compounds of Aromatic Hydrocarbons.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

NITROETHANE
Description: Colorless liquid.
Formula: $C_2H_5NO_2$
Constants:
Mol. Wt. 75.07
B. P. 114.0°C
Freezing P. −90°C
Flash P. 106°F (T.O.C.)
Density 1.052 @20°/20°C
Autoign. Temp. 778°F
Vap. Press. 15.6 mm @20°C
Vap. D. 2.58
Toxicity: See Nitroparaffins.
MAC: ACGIH (accepted); 100 parts per million in air; 307 milligrams per cubic meter of air.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

2-NITRO-2-ETHYL-1,3-PROPANEDIOL.
Description: Crystalline material.
Formula:
$CH_2OHC(C_2H_5)NO_2CH_2OH$
Constants:
Mol. Wt. 149.15
M. P. 56 - 57°C
B. P. Decomposes
Toxicity: Unknown
Fire Hazard: Unknown
Disaster Control: See Nitrates.
Storage and Handling: Section 7

NITROGEN
Description: Colorless gas, colorless liquid or cubic crystals at low temperatures.
Formula: N_2
Constants:
Mol. Wt. 28.02
M. P. −210.0°C
B. P. −195.8°C
Density 1.2506 g/liter @0°C; (liq.) 0.808 @−195.8°C
Toxicity: None. In high concentrations it is a simple asphyxiant. The release of nitrogen from solution in the blood, with formation of small bubbles, is the cause of most of the symptoms and changes found in compressed air illness (caisson disease). See also Argon.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Nonflammable gas; green label.
Coast Guard Classification: Noninflammable gas; green gas label.

NITROGEN BROMIDE
Synonym: Nitrogen tribromide.
Description: Crystalline solid.
Formula: NBr_3
Constant:
Mol. Wt. 253.8
Toxicity: Details unknown; probably highly toxic. See Bromides.
Explosion Hazard: Severe, when shocked, exposed to heat or flame or by spontaneous chemical reaction.
Disaster Control: Dangerous; shock will explode it; on decomposition, it emits highly toxic fumes of bromine; can react vigorously

with reducing materials.
Storage and Handling: Section 7

NITROGEN CHLORIDE

Synonym: Nitrogen trichloride.
Description: Volatile, yellowish oil or rhombic crystals; pungent odor.
Formula: NCl_3
Constants:
  Mol. Wt. 120.38
  M. P. Below −40°C
  B. P. Below + 71°C
  Density 1.653
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: Ingestion 2; Inhalation 2
Explosion: Severe, when shocked, exposed to heat or flame or by spontaneous chemical reaction. Certain common materials catalyze its decomposition. It is particularly sensitive when it contains impurities.
Explosive Range: @95°C.
Disaster Control: Dangerous; even slight shock will explode it; on decomposition, it emits highly toxic fumes of chlorine; can react vigorously with reducing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

NITROGEN DIOXIDE

Synonym: Nitrogen Tetroxide.
Description: Colorless solid to yellow liquid.
Formula: NO_2
Constants:
  Mol. Wt. 46
  M. P. −9.3°C (yellow liquid)
  B. P. 21°C (red brown gas with decomp.)
  Density 1.491 @0°C
  Vap. Press. 400 mm @8.0°C
Toxicity: Highly toxic. See Nitrogen Oxides.
MAC: ACGIH (accepted); 5 parts per million in air; 9 milligrams per cubic meter of air.
Disaster Control: See Nitrogen Oxides.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Poison A (liquid); poison gas label.
  Coast Guard Classification: Poison A (liquid); poison gas label.

NITROGEN FLUORIDE. See Nitrogen Trifluoride.

NITROGEN IODIDE. See Nitrogen Triiodide.

NITROGEN MUSTARD

Synonym: HN - 1.
Description: Dark liquid; no odor if pure.
Formula: $(ClCH_2CH_2)_2NC_2H_5$
Constants: Mol. Wt. 170.08
  M. P. 1°C
  B. P. 85°C @10 mm
  Density 1.09 @25°C
  Vap. Press. 0.17 mm @25°C
  Vap. D. 5.9
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: Irritant 3; Ingestion 3; Inhalation 3
  Chronic Systemic: U
Disaster Control: Highly dangerous! A military poison!
Ventilation Control: (use moderate rate): Section 2

NITROGEN OXIDES (Except Nitrous)

Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: Ingestion 2; Inhalation 2
MAC: ACGIH (accepted); 5 parts per million in air.
Toxicology: Exposure to nitrous fumes may occur whenever nitric acid acts upon organic materials, such as wood, sawdust and refuse; it occurs when nitric acid is heated, and when organic nitro compounds are burned, as for

example, celluloid, nitrocellulose (guncotton) and dynamite. The action of nitric acid upon metals, as in metal etching and pickling, also liberates the fumes. In high-temperature welding, as with the oxyacetylene or electric torch, the nitrogen and oxygen of the air unite to form oxides of nitrogen. Exposure may also occur in many manufacturing processes when nitric acid is made or used.

The oxides of nitrogen are somewhat soluble in water, reacting with it in the presence of oxygen to form nitric and nitrous acids. This action takes place deep in the respiratory system. The acids formed cause congestion of the throat and bronchi, and edema of the lungs. They are neutralized by the alkalis present in the tissues, with the formation of nitrates and nitrites. The latter may cause some arterial dilatation, fall in blood pressure, headache and dizziness, and there may be some formation of methemoglobin. However, the nitrite effect is of secondary importance.

Because of their relatively low solubility in water, the nitrogen oxides are only slightly irritant to the mucous membranes of the upper respiratory tract. Their warning power is therefore low, and dangerous amounts of the fumes may be breathed before the workman notices any real discomfort. Higher concentrations (60 to 150 ppm) cause immediate irritation of the nose and throat, with coughing and burning in the throat and chest. These symptoms often clear up on breathing fresh air, and the workman may feel well for several hours. Some 6 to 24 hours after exposure, he develops a sensation of tightness and burning in the chest, shortness of breath, sleeplessness and restlessness. Dyspnea and air hunger may increase rapidly, with development of cyanosis and loss of consciousness, followed by death. In cases which recover from the pulmonary edema, there is usually no permanent disability but pneumonia may develop later. Concentrations of 100 to 150 ppm are dangerous for short exposures of 30 to 60 minutes. Concentrations of 200 to 700 ppm may be fatal after even very short exposures.

Continued exposure to low concentrations of the fumes, insufficient to cause pulmonary edema, is said to result in chronic irritation of the respiratory tract, with cough, headache, loss of weight, loss of appetite, dyspepsia, corrosion of the teeth and gradual loss of strength.

Exposure to nitrous fumes is always potentially serious, and persons so exposed should be kept under close observation for at least 48 hours.

Disaster Control: Dangerous; when heated they evolve highly toxic fumes; they will react with water or steam to produce heat and corrosive liquids; they can react vigorously with reducing materials.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

NITROGEN OXYCHLORIDE. See Nitrosyl Chloride.

NITROGEN PENTOXIDE

Synonym: Nitric anhydride.

Description: Hexagonal (rhombic) white crystals.

Formula: N_2O_5

Constants:
  Mol. Wt. 108.02
  M. P. 30°C
  B. P. 47°C (decomp.)
  Density 1.642 @18°C
  Vap. Press. 400 mm @24.4°C

Toxicity: See Nitrogen Oxides.

MAC: ACGIH (accepted); 25 parts per million in air; 111 milligrams per cubic meter of air.

Fire Hazard: Moderate; when heated it liberates oxygen (Section 6).

Explosion Hazard: Dangerous; at 122°F it decomposes violently liberating oxygen.

Disaster Control: Dangerous; when

heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; will react with water or steam to produce toxic and corrosive fumes; can react with reducing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

NITROGEN PEROXIDE. See Nitric Oxide.
Shipping Regulations: Section 11.
I.C.C. Classification: Poison A; poison gas label.
Coast Guard Classification: Poison A; poison gas label.

NITROGEN SELENIDE
Description: Solid material.
Constant:
B. P. Explodes @446°F
Toxicity: Highly toxic. See Selenium Compounds.
Explosion Hazard: Dangerous, when shocked or exposed to a temperature of 446°F.
Disaster Control: Dangerous; shock will explode it; on decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of selenium and oxides of nitrogen.
Storage and Handling: Section 7

NITROGEN SULFIDE
Description: An unstable, solid material.
Constant:
M. P. Explodes @401°F
Toxicity: Details unknown. See also Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: Severe, when shocked or exposed to heat or flame.
Disaster Control: Dangerous; shock or heat (400°F) will explode it; on decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of nitrogen and oxides of sulfur.
Storage and Handling: Section 7

NITROGEN TETROXIDE. See Nitrogen Dioxide.
Shipping Regulations: Section 11.
Coast Guard Classification: Poison A; poison gas label.

NITROGEN TRICHLORIDE. See Nitrogen Chloride.

NITROGEN TRIFLUORIDE
Description: Colorless gas.
Formula: NF_3
Constants:
Mol. Wt. 71.01
M. P. -216.6°C
B. P. -120°C
Density liquid 1.537 @-129°C
Toxicity: Highly toxic. See Fluorides and Hydrofluoric Acid.
Explosion Hazard: Severe, when shocked, exposed to heat or flame or by spontaneous chemical reaction.
Disaster Control: Dangerous; shock will explode it; on decomposition, it emits highly toxic fumes of fluorides; can react vigorously with reducing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

NITROGEN TRIIODIDE
Description: Black crystals.
Formula: NI_3
Constants:
Mol. Wt. 394.77
M. P. Explodes
B. P. Sublimes in vacuo
Toxicity: Details unknown. See also Iodides.
Explosion Hazard: Severe; when shocked, exposed to heat or flame or by spontaneous chemical reaction. It has no known uses as an explosive, because it is far too sensitive in the dry state to store or handle safely. If this material must be worked with, it should be kept wet. A convenient way of keeping it wet is with ether; when it is needed in the dry state, it simply has to be taken out into the open and the ether will evaporate, leaving it perfectly dry. When dry, it will explode when given the slightest touch, vibration or raise in temperature. Even a puff of air directed into it can cause it to detonate. It is a high explosive and is very violent. It can be destroyed by throwing a quantity of it into large bodies of water, flowing streams or rivers.

NITROGEN TRIIODIDE MONOAMMINE

Description: Dark red rhombic crystals.
Formula: NI_3NH_3
Constants:
  Mol. Wt. 411.80
  M. P. Decomp. below 20°C
  B. P. Explodes
  Density 3.5
Toxicity: Details unknown.
Explosion Hazard: Severe. This material is extremely unstable when dry. The slightest shock or heat will cause it to decompose explosively. It should be kept moist.
Disaster Control: Dangerous. On decomposition it emits highly toxic fumes of iodine and ammonia.

NITROGEN TRIOXIDE

Description: Bluish gas.
Formula: NO_3
Constants:
  Mol. Wt. 62.01
  M. P. Decomp. slightly at ordinary temperatures.
Toxicity: See Nitrogen Oxides.
MAC: ACGIH (accepted); 25 parts per million in air; 63 milligrams per cubic meter of air.
Disaster Control: See Nitrogen Dioxide.
Storage and Handling: Section 7

NITROGLYCERIN

Synonyms: Glycerol trinitrate; blasting oil; soup.
Description: Colorless to yellow liquid.
Formula: $C_3H_5(ONO_2)_3$
Constants:
  Mol. Wt. 227.09
  M. P. 11°C
  B. P. Expl. @260°C
  Flash P. Explodes
  Density 1.601
  Vap. Press. 1 mm @127°C
  Vap. D. 7.84
Toxic Hazard Rating:
  Acute Local: Irritant 2
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
  Chronic Local: Irritant 2
  Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Toxicology: The symptoms of nitroglycerin poisoning are headaches and reduced blood pressure, excitement, vertigo, fainting, respiratory rales, and cyanosis. If this material is taken internally, it causes respiratory difficulties and death, due to respiratory paralysis. Severe poisoning often manifests itself at first by confusion, pugnaciousness, hallucinations, and maniacal manifestations. The most common complaint is headache which is noted upon commencing work but soon passes off. A break in the work interrupts this acclimatization and workers sometimes resort to the device of moistening their hat bands with nitroglycerin when they are off the job so as to maintain this effect during absence from their occupation. Furthermore it can be absorbed through uninjured skin and may produce eruptions on the palms and intradigital spaces of the hands. In normal manufacture and use of dynamite, the physiological effects of nitroglycerin cause only temporary discomfort and are not injurious to health.
MAC: ACGIH (accepted); 0.5 parts per million in air; 5.0 milligrams per cubic meter in air.
Fire Hazard: Dangerous, when exposed to heat or flame or by spontaneous chemical reaction.
Spontaneous Heating: No
Explosion Hazard: Severe, when shocked or exposed to heat or flame. Nitroglycerin is a powerful explosive, very sensitive to mechanical shock. Small quantities of it can readily be detonated by a hammer blow on a hard surface, particularly when it has been absorbed in filter paper. Frozen nitroglycerin is somewhat less sensitive than the liquid. However, a half or partially thawed out mixture is more sensitive than either one. See also Explosives, High and Dynamites.
Disaster Control: Highly dangerous; shock, heat and flame will explode it, and toxic fumes evolved on decomposition.
Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
 I. C. C. Classification: Cannot be shipped by common carrier.
 Coast Guard Classification: Prohibited.

NITROGLYCERIN, LIQUID, DESENSITIZED. See Nitroglycerin.
Shipping Regulations: Section 11.
 Coast Guard Classification: Not permitted.

NITROGUANIDINE
Description: Yellow solid.
Formula: $H_2NC(NH)NHNO_2$
Constants:
 Mol. Wt. 104.1
 M. P. 246°C
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame or by chemical reaction with oxidizers (Section 6).
Explosion Hazard: Severe, when shocked or exposed to heat or flame. Nitroguanidine is known as a flashless or cool explosive. It is about as powerful as TNT and is normally used mixed with colloided nitrocellulose, in which form it yields a propellent powder which gives no flash from the muzzle of the gun thus serving as a great advantage to the military. It has also been used mixed with ammonium nitrate and paraffin wax as a trench mortar ammunition.
Disaster Control: Dangerous; shock will explode it; when heated to decomposition, it emits highly toxic fumes; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

NITROHYDRENE
Description: An oil.
Composition: Nitroglycerin + Nitrosucrose.
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame or by chemical reaction (Section 6).
Explosion Hazard: Severe, when shocked or exposed to heat. It is a powerful explosive, approximately as powerful as nitroglycerin, and is used to stretch glycerin supplies. It is made up by dissolving up to 25 percent of sucrose in glycerin and nitrating the resulting mixture to give an explosive oil. This procedure saves considerable quantities of glycerin. The material is almost exactly like nitroglycerin. See also Explosives, High.
Disaster Control: Dangerous; shock and heat will explode it; on decomposition it emits highly toxic fumes of oxides of nitrogen; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

NITROHYDROCHLORIC ACID. See Aqua Regia.
Shipping Regulations: Section 11.
 I. C. C. Classification: Corrosive liquid; white label.
 Coast Guard Classification: Corrosive liquid; white label.

NITROHYDROCHLORIC ACID, DILUTED. See Aqua Regia.
Shipping Regulations: Section 11.
 I. C. C. Classification: Corrosive liquid; white label.
 Coast Guard Classification: Corrosive liquid; white label.

NITRO JUTE
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Severe, when shocked or exposed to heat. See also Explosives, High.
Disaster Control: Dangerous; shock or heat will explode it; on decomposition it emits highly toxic fumes of oxides of nitrogen; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

NITROLEVULOSE
Synonym: Dextrose nitrate.
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Severe, when shocked or exposed to heat. See also Explosives, High and Nitrates.
Disaster Control: Dangerous; shock

or heat will explode it; on decomposition, it emits highly toxic fumes of oxides of nitrogen; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

NITROMANNITE

Synonym: Nitromannitol.
Description: Needles.
Formula: $C_6H_8(NO_3)_6$
Constants:
  Mol. Wt. 452.2
  M. P. 166.1°C (expl. @125°C)
  B. P. 295°C @3.5 mm
  Density 1.489 @20°/4°C
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Severe, when shocked or exposed to heat. See also Explosives, High and Nitrates.
Disaster Control: Dangerous; shock or heat will explode it; on decomposition, it burns, emits highly toxic fumes of oxides of nitrogen; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

NITROMETHANE

Description: A liquid.
Formula: CH_3NO_2
Constants:
  Mol. Wt. 61.04
  B. P. 101°C
  Freezing P. −29°C
  Flash P. 95°F (C.C.)
  Density 1.130 @20°/4°C
  Autoign. Temp. 785°F
  Vap. Press. 27.8 mm @20°C
  Vap. D. 2.11
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: U
MAC: ACGIH (accepted); 100 parts per million in air; 250 milligrams per cubic meter of air.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when shocked or exposed to heat or flame.
Explosive Range: 7.3% (L.E.L.)
Disaster Control: Dangerous; shock or heat will explode it; on decomposition it emits highly toxic fumes of oxides of nitrogen; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

2-NITRO-2-METHYL-1,3-PROPANEDIOL

Description: Crystalline material.
Formula: $CH_2OHC(CH_3)NO_2CH_2OH$
Constants:
  Mol. Wt. 135.12
  M. P. 147 - 149°C
  B. P. Decomposes
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; on decomposition, it emits highly toxic fumes of oxides of nitrogen; can react with oxidizing materials.
Storage and Handling: Section 7

2-NITRO-2-METHYL-1-PROPANOL

Description: Crystalline material.
Formula: $CH_3C(CH_3)NO_2CH_2OH$
Constants:
  Mol. Wt. 119.12
  M. P. 90 - 91°C
  B. P. 95°C @10 mm
Toxicity: Unknown
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

NITROMOLASSES

Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Moderate, when shocked or exposed to heat or flame. See also Explosives, High and Nitrates.
Disaster Control: Dangerous; shock or heat will explode it; on decomposition, it emits highly toxic fumes of oxides of nitrogen; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

NITRONAPHTHALENE

Description: Yellow crystals.
Formula: $C_{10}H_7NO_2$
Constants:
  Mol. Wt. 173.16
  M. P. 58.8°C
  B. P. 304°C
  Flash P. 327°F (C.C.)
  Density 1.331 @4°/4°C
  Vap. D. 5.96
Toxic Hazard Rating:
  Acute Local: Irritant 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat.
To Fight Fire: Water, carbon dioxide, dry chemical, carbon tetrachloride of water spray (Section 6).
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Personal Hygiene: Section 3
Storage and Handling: Section 7

NITROPARAFFINS

Synonyms: 2-Nitropropane, nitroethane, nitromethane, 1-nitropropane.
Constant:
  Flash P. 103 - 120°F
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: Irritant 1
  Chronic Systemic: Ingestion 1; Inhalation 1
Fire Hazard: Moderate. See Nitrates.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Dry salts of nitromethane and inorganic bases are explosive. Otherwise the mono nitro-paraffins are relatively stable. Impact under confined conditions can cause explosions of mono nitro methane. Avoid heating it to above 450°F.
Disaster Control: See Nitrates.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

m-NITROPHENOL

Description: Monoclinic prisms.
Formula: $C_6H_5NO_3$
Constants:
  Mol. Wt. 139.1
  M. P. 97°C
  B. P. 194°C @70 mm
  Density 1.485 @20°/4°C
Toxicity: See p-Nitrophenol.
Disaster Control: See Nitrates.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

o-NITROPHENOL

Description: Light yellow crystals; aromatic odor.
Formula: $C_6H_5NO_3$
Constants:
  Mol. Wt. 139.1
  M. P. 45°C
  B. P. 214.5°C
  Density 1.657 @20°C
  Vap. Press. 1 mm @49.3°C
Toxicity: See p-Nitrophenol.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

p-NITROPHENOL

Description: Colorless to slightly yellow crystals.
Formula: $C_6H_5NO_3$
Constants: Mol. Wt. 139.1
  M. P. 113 - 114°C
  B. P. 279°C (decomp.)
  Density 1.270 @120°/4°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: Ingestion 3; Inhalation 3
Disaster Control: See Nitrates.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

m-NITROPHENOL DIAZONIUM PERCHLORATE

Description: A solid.
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).

Explosion Hazard: Severe, when shocked or exposed to heat. See also Explosives, High.
Disaster Control: Dangerous; shock will explode it; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of nitrogen; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

1-NITROPROPANE

Description: Colorless liquid.
Formula: $CH_3CH_2CH_2NO_2$
Constants:
  Mol. Wt. 89.09
  B. P. 132°C
  Freezing P. −108°C
  Flash P. 120°F (T.O.C.)
  Density 1.003 @20°/20°C
  Autoign. Temp. 789°F
  Vap. Press. 7.5 mm @20°C
  Vap. D. 3.06
Toxicity: Moderate. See Nitroparaffins.
Fire Hazard: Moderate, when exposed to heat or open flame (Section 6).
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

2-NITROPROPANE

Description: Colorless liquid.
Formula: $(CH_3)_2CHNO_2$
Constants:
  Mol. Wt. 89.09
  B. P. 120°C
  Freezing P. −93°C
  Flash P. 103°F (T.O.C.)
  Density 0.992 @20°/20°C
  Autoign. Temp. 802°F
  Vap. Press. 10 mm @15.8°C
  Vap. D. 3.06
Toxicity: Moderate. See Nitroparaffins.
MAC: ACGIH (accepted); 50 parts per million in air; 182 milligrams per cubic meter of air.
Fire Hazard: Moderate, when exposed to heat or open flame (Section 6).
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride.
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

NITROPRUSSIDES

Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: Ingestion 3; Inhalation 3
Toxicology: According to some observers, sodium nitroprusside decomposes in the body liberating cyanide; hence the toxicity is that of cyanides. There may be a nitrite effect in nonfatal cases. See also Cyanides and Nitrites.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes; they emit highly toxic fumes of cyanides and oxides of nitrogen.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

NITROPYRIDINE

Description: Liquid.
Formula: $C_5H_4N_2O_2$
Constants: Mol. Wt. 124.1
  Autoign Temp. 725°F
Toxicity: Details unknown; probably highly toxic. See also Pyridine.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, carbon dioxide, dry chemical, carbon tetrachloride or water spray (Section 6).
Explosion Hazard: Unknown.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react with oxidizing materials.
Storage and Handling: Section 7

NITROSACCHAROSE

Synonym: Nitrosugar.
Description: White solid.
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Moderate, when shocked or exposed to heat.

See also Explosives, High and Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

p-NITROSODIMETHYLANILINE
Description: Green leaflets.
Formula: $NOC_6H_4N(CH_3)_2$
Constants:
Mol. Wt. 150.14
M. P. 87.8°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 2
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Irritant 2; Allergen 2
Chronic Systemic: Ingestion 3; Inhalation 3
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

n-NITROSODIPHENYLAMINE
Toxicity: Details unknown. See also Amines.
Fire Hazard: Dangerous, when exposed to heat or flame or by chemical reaction (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

NITROSOGUANIDINE
Description: A solid.
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Severe, when shocked or exposed to heat or flame. See also Explosives, High and Nitrates.
Disaster Control: Dangerous; shock will explode it; on decomposition, it emits highly toxic fumes of oxides of nitrogen; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

NITROSOMETHYLUREA
Description: Powder.
Formula: $CH_3NHCONHNO$
Constant:
Mol. Wt. 89.1
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Toxicology: Has been known to cause a contact dermatitis of the poison ivy type (Section 9).
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: See Nitrates.
Personal Hygiene: Section 2
Storage and Handling: Section 7

NITROSOMETHYLURETHANE
Description: Solid.
Formula: $CH_3NNOCOOC_2H_5$
Constant:
Mol. Wt. 132.2
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

p-NITROSOPHENOL
Synonyms: Quinone monoxime.
Description: Yellow, rhombic needles.
Formula: NOC_6H_4OH
Constants:
Mol. Wt. 123.11
M. P. 126°C Decomposes
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame; burns explosively (Section 6).
Explosion Hazard: Moderate, when exposed to heat. See also Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

NITROSOPHENOL DIMETHYLPYRAZOLE

Description: A solid.
Toxicity: Unknown
Fire Hazard: See Nitrates.
Explosion Hazard: Severe, when exposed to heat. See also Explosives, High and Nitrates.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

NITROSO PYRAZOLE

Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

NITRO STARCH

Synonym: Starch nitrate.
Description: Solid.
Formula: $C_{12}H_{12}(NO_2)_8O_{10}$
Constant:
  Mol. Wt. 684.30
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Severe, when shocked or exposed to heat or flame. It is a powerful high explosive. Nitrostarch is not a definite compound, but a mixture of various nitric acid esters of starch of different degrees of nitration. It is used as an ingredient of blasting explosives, for quarrying, and as a demolition explosive. See also Nitrates.
Disaster Control: See Explosives, High and Nitrates.
Storage and Handling: Section 7

NITROSTYRENE

Toxicity: Details unknown. See also Styrene.
Fire Hazard: Moderate, when exposed to heat or flame.
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

NITROSYL BROMIDE

Description: Brown gas or dark brown liquid.
Formula: NOBr
Constants:
  Mol. Wt. 109.92
  M. P. −55.5°C
  B. P. −2°C
  Density > 1.0
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: See Bromides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

NITROSYL CHLORIDE

Synonym: Nitrogen oxychloride.
Description: Yellow gas or yellow liquid or crystals; irritating odor.
Formula: NOCl
Constants:
  Mol. Wt. 65.47
  M. P. −64.5°C
  B. P. −5.8°C
  Density (liq.) 1.250 @ 30°C
  Vap. Press. 76 mm @ −50°C
  Vap. D. 2.3
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: See Chlorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Nonflammable gas; green label.

Coast Guard Classification: Noninflammable gas; green gas label.

NITROSYL FLUORIDE

Synonym: Nitrogen oxyfluoride.
Description: Colorless gas.
Formula: NOF
Constants:
  Mol. Wt. 49.01
  M. P. -134°C
  B. P. -56°C
  Density 2.176 g/l
Toxicity: Highly toxic. See Fluorides and Hydrofluoric Acid.
Disaster Control: Dangerous! See Fluorides and Hydrofluoric Acid.
Storage and Handling: Section 7

NITROSYL SULFURIC ACID

Synonym: Chamber crystals.
Description: Crystalline, colorless solid.
Formula: $ONOSO_3H$
Constants:
  Mol. Wt. 127.08
  M. P. 73°C (for crystalline material)
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates and Sulfates.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

NITROSYLSULFURIC ANHYDRIDE

Description: Tetragonal crystals.
Formula: $(NOSO_3)_2O$
Constants:
  Mol. Wt. 236.15
  M. P. 217°C
  B. P. 360°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen and oxides of sulfur; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

m-NITROTOLUENE

Description: Liquid.
Formula: $CH_3C_6H_4NO_2$
Constants:
  Mol. Wt. 137.1
  M. P. 15.1°C
  B. P. 231.9°C
  Flash P. 223°F (C.C.)
  Density 1.1630 @15°/4°C
  Vap. Press. 1 mm @50.2°C
  Vap. D. 4.72
Toxicity: Moderate. See also p-Nitrotoluene.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: See Nitrates.
Storage and Handling: Section 7

o-NITROTOLUENE

Description: Yellowish liquid.
Formula: $C_7H_7NO_2$
Constants:
  Mol. Wt. 137.1
  M. P. -4.1°
  B. P. 222.3°C
  Flash P. 223°F (C.C.)
  Density 1.1622 @19°/15°C
  Vap. Press. 1 mm @50°C
  Vap. D. 4.72
Toxicity: Moderate. See p-Nitrotoluene.
Fire Hazard: Moderate, when exposed to heat or open flame.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

p-NITROTOLUENE

Synonym: Methyl nitrobenzene.
Description: Yellowish crystals.
Formula: $C_7H_7NO_2$
Constants:
  Mol. Wt. 137.1
  M. P. 51.9°C
  B. P. 238.3°C
  Flash P. 223°F (C.C.)

Density 1.286
Vap. Press. 1 mm @53.7°C
Vap. D. 4.72
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
MAC: ACGIH (accepted); 5 parts per million in air; 28 milligrams per cubic meter of air.
Fire Hazard: Moderate, when exposed to heat or open flame.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: See Nitrates.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

m-NITRO-p-TOLUIDINE
Description: Clear liquid.
Formula: $C_7H_6NH_2NO_2$
Constants:
Mol. Wt. 168.15
M. P. 241°F
Flash P. 315°F (C.C.)
Density 1.312
Vap. D. 5.80
Toxicity: Details unknown. See also Toluidine and Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: See Nitrates.
Storage and Handling: Section 7

NITROTRICHLOROMETHANE. See Chloropicrin.

6-NITRO-2,4-bis (TRICHLOROMETHYL)-1,3-BENZODIOXANE
Toxicity: Details unknown. See also Nitro Compounds of Aromatic Hydrocarbons.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of nitrogen.
Storage and Handling: Section 7

m-NITROTRIFLUOROMETHYLBENZENE. See m-Nitrobenzotrifluoride.

NITROUREA
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
Explosion Hazard: Severe, when shocked or exposed to heat.
See also Explosives, High and Nitrates.
Disaster Control: Dangerous; shock will explode it; when heated to decomposition it emits highly toxic fumes of oxides of nitrogen; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

NITROUS ACID
Description: Pale blue solutions.
Formula: HNO_2
Constant:
Mol. Wt. 47.02
Toxicity: See Nitrites.
Fire Hazard: Moderate, by chemical reaction; a powerful oxidizer (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen.
Storage and Handling: Section 7

NITROUS FUMES. See Nitrogen Dioxide.

NITROUS OXIDE
Synonym: Laughing gas.
Description: Colorless gas or liquid or cubic crystals.
Formula: N_2O
Constants:
Mol. Wt. 44.02
M. P. −102.4°C
B. P. −88.49°C
Density 1.977 g/l; liquid 1.226 @−89°C
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Inhalation 2
Chronic Local: 0
Chronic Systemic: U
Fire Hazard: Moderate, by chemical reaction; it supports combustion (Section 6).

Explosion Hazard: Moderate; it can form an explosive mixture with air.
Disaster Control: Slightly dangerous, as shock can shatter the container with explosive force.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Nonflammable gas; green label.
Coast Guard Classification: Noninflammable gas; green gas label.

m-NITROXYLOL

Synonym: m-Nitroxylene.
Description: Light yellow liquid.
Formula: $C_6H_3(CH_3)_2NO_2$
Constants:
Mol. Wt. 151.2
M. P. 2°C
B. P. 244°C
Density 1.135 @15°/4°C
Toxicity: Details unknown; probably toxic. See also Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Poison B; poison label.
I. C. C. Classification: Poison B; poison label.

o-NITROXYLOL

Synonym: o-Nitroxylene.
Description: Yellowish liquid or solid.
Formula: $C_6H_3(CH_3)_2NO_2$
Constants:
Mol. Wt. 151.2
M. P. 29°C
B. P. 258°C
Density 1.139
Toxicity: Details unknown. See Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7
Shipping Regulations: See m-Nitroxylol.

p-NITROXYLOL

Synonym: p-Nitroxylene.
Description: Liquid.
Formula: $C_6H_3(CH_3)_2NO_2$
Constants:
Mol. Wt. 151.2
B. P. 240°C
Density 1.132
Toxicity: Details unknown. See Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: Moderate, when exposed to heat or flame.
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7
Shipping Regulations: See m-Nitroxylol.

NITRYL CHLORIDE

Description: Pale yellow or brown gas.
Formula: NO_2Cl
Constants:
Mol. Wt. 81.47
M. P. < -31°C
B. P. 5°C
Density 2.57 g/l; liquid 1.32 @ 14°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; shock can shatter the compressed gas container with explosive force; when heated to decomposition, it emits highly toxic fumes of chlorides and nitrogen dioxide; will react with water or steam to produce corrosive fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

NONAETHYLENE GLYCOL

Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

n-NONANE

Description: Colorless liquid.
Formula: C_9H_{20}

Constants:
Mol. Wt. 128.25
M. P. -53.7°C
B. P. 150.7°C
Flash P. 88°F (C.C.)
Density 0.718 @20°/4°C
Autoign. Temp. 545°F
Vap. Press. 10 mm @38.0°C
Vap. D. 4.41
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Inhalation 1
Chronic Local: 0
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, in the form of gas, when exposed to flame.
Explosive Range: 0.74 - 2.9%
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

NONANOIC ACID

Synonym: Pelargonic acid.
Description: Colorless, oily liquid.
Formula:
$CH_3(CH_2)_7CO_2H$
Constants:
Mol. Wt. 158.2
M. P. 12°C
B. P. 254°C
Density 0.9055 @20°/4°C
Vap. D. 5.46
Toxicity: Unknown
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

NONETHYLENE GLYCOL HEXARICINOLEATE

Constant:
Flash P. 530°F (O.C.)
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

NONETHYLENE GLYCOL MONOSTEARATE

Constant:
Flash P. 505°F (O.C.)
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

NONYL ACETATE

Description: Liquid.
Formula:
$CH_3COOCH[CH_2CH(CH_3)_2]_2$
Constants:
Mol. Wt. 186.29
M. P. -48.1°C
B. P. 192.4°C
Flash P. 155°F (O.C.)
Density 0.8530 @20°/20°C
Vap. D. 6.42
Toxicity: Details unknown. See also Esters and Acetic Acid.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

NONYL ALDEHYDE CYANOHYDRIN

Description: Liquid.
Formula:
$(CH_3)_3CCH_2CH(CH_3)CH_2CH(OH)CN$
Constants:
Mol. Wt. 169
B. P. Decomp. to HCN
Density 0.8976
Vap. D. 5.83
Toxicity: Hazardous, as it decomposes to HCN on boiling. See Cyanides.
Fire Hazard: Moderate, when exposed to heat or by spontaneous chemical reaction (Section 6).
Explosion Hazard: See Cyanides.
Disaster Control: Dangerous! See Cyanides.
Storage and Handling: Section 7

n-NONYLAMINE

Synonym: 1-Amino nonane.
Description: Colorless liquid.
Formula: $CH_3(CH_2)_7CH_2NH_2$

Constants:
Mol. Wt. 143.3
B. P. 202.2°C
Density 0.785
Toxicity: Details unknown. See also Amines.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

NONYL BENZOL

Synonym: Nonyl benzene.
Description: Liquid.
Formula: $C_6H_5C_9H_{19}$
Constants:
Mol. Wt. 204.3
B. P. 473°F
Flash P. 210°F (C.C.)
Density 0.86
Toxicity: Details unknown. See also Benzene.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

NONYL NAPHTHALENE

Description: Liquid.
Formula: $C_{10}H_7C_9H_{19}$
Constants:
Mol. Wt. 254.4
B. P. 626°F
Flash P. 320°F (C.C.)
Density 0.94
Toxicity: Details unknown. See also Naphthalene.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

NONYL PHENOL

Description: Clear, viscous, straw-colored liquid.
Formula: $C_6H_4OHC_9H_{19}$
Constants:
Mol. Wt. 220.34
B. P. 290 - 301°C
Pouring P. 2°C
Flash P. 300°F (T.O.C.)
Density 0.949 @20°/4°C
Vap. D. 7.59
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

NONYLTRICHLOROSILANE

Formula: $C_9H_{19}SiCl_3$
Constants:
Mol. Wt. 261.7
Density 1.072 @25°C
Toxicity: Highly toxic. See Chlorosilanes.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

NORNICOTINE

Synonym: β-Pyridyl-α-pyrrolidine.
Description: Hygroscopic, viscous liquid.
Formula: $C_9H_{12}N_2$
Constants:
Mol. Wt. 148.2
B. P. 270°C
Density 1.0737 @20°/4°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

"NOVOCAINE." See Procaine Hydrochloride.

NUISANCE DUSTS

Toxicity: Variable, depending upon composition. Cause local irritation of eyes, nose, throat and lungs. Some may lead to chronic bronchitis, emphysema and bronchial asthma. Dermatitis may result from short contact. Asthma, angioneurotic edema, hives, etc. may result from short periods of inhalation. Atopic eczema, angioneurotic edema, hives, etc. may also result from prolonged contact. See also Section 9.

MAC: ACGIH (accepted): < 100 million particles per cubic foot.

Ventilation Control (use moderate rate: Section 2

O

OAT DUST
Toxic Hazard Rating:
  Acute Local: Irritant 1; Allergen 1; Inhalation 1
  Acute Systemic: U
  Chronic Local: Allergen 1; Inhalation 1
  Chronic Systemic: Inhalation 1
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: Slight, when exposed to flame.
Personal Hygiene: Section 3
Ventilation Control (use normal rate): Section 2

OCTACHLORO-CAMPHENE
Description: Yellow, waxy solid.
Formula: $C_{10}H_{10}Cl_8$ (approx.)
Constant:
  Mol. Wt. 414.2 (approx.)
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: Ingestion 2; Inhalation 2
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

OCTACHLOROTRISILANE
Formula: Si_3Cl_8
Constants:
  Mol. Wt. 368.3
  M. P. -67°C
  B. P. 211.4°C
  Vap. Press. 1 mm @46.3°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

1-OCTADECANOL. See Stearyl Alcohol.

1-OCTADECENE
Synonyms: 1-Octadecyne; hexadecyl acetylene.
Description: Crystals.
Formula: $HC{:}C(CH_2)_{15}CH_3$
Constants:
  Mol. Wt. 250.5
  M. P. 26°C
  B. P. 180°C @15 mm
  Density 0.7884 @20°/4°C
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

OCTADECENYL ALDEHYDE
Description: Liquid.
Formula: $C_{18}H_{36}O$
Constants:
  Mol. Wt. 266.5
  B. P. 167°C
  Density 0.847
  Vap. D. 9.18
Toxicity: Details unknown. See also Aldehydes.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

OCTADECYL ALCOHOL
Description: Crystals.
Formula: $CH_3(CH_2)_{16}CH_2OH$
Constants:
  Mol. Wt. 270.5
  M. P. 58°C

B. P. 349.5°C
Density 0.8124 @59°/4°C
Vap. Press. 1 mm @150.3°C
Toxicity: Unknown. See Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

N-OCTADECYL DISODIUM SULFOSUCCINAMATE

Description: Cream-colored soft paste.
Formula: $C_{22}H_{41}O_6NSNa_2$
Constant:
Mol. Wt. 493
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur and nitrogen.
Storage and Handling: Section 7

OCTADECYLISOCYANATE

Formula: $C_{18}H_{35}NCO$
Constants:
Mol. Wt. 295.5
M. P. 15 - 18°C
B. P. 150 - 180°C @¾ mm
Density 0.86 @25°C
Toxicity: Probably toxic. See also Cyanates.
Disaster Control: See Cyanates.
Storage and Handling: Section 7

OCTADECYL TRICHLOROSILANE

Formula: $C_{18}H_{37}SiCl_3$
Constants:
Mol. Wt. 268.01
B. P. 223°C @10 mm
Density 0.984 @25°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

OCTAMETHYL PYROPHOSPHORAMIDE

Synonym: OMPA.
Description: Water-white liquid.
Formula: $C_8H_{24}N_4P_2O_3$
Constants:
Mol. Wt. 286.34
M. P. 20 - 21°C
B. P. 137 - 142°C @2 mm
Density 1.137 @25°/4°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

OCTAMETHYL TRISILOXANE

Description: Liquid.
Formula: $C_8H_{24}O_2Si_3$
Constants:
Mol. Wt. 236.5
B. P. 150.2°C
Freezing P. −80°C
Density 0.82
Vap. Press. 1 mm @7.4°C; 10 mm @43.1°C
Toxicity: Details unknown. See also Siloxanes.
Disaster Control: Slightly dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

OCTANE

Description: Clear liquid.
Formula: $CH_3(CH_2)_6CH_3$
Constants:
Mol. Wt. 114.23
B. P. 125.8°C
Freezing P. −56.5°C
Flash P. 60°F (C.C.)
Density 0.7036 @20°/4°C
Autoign. Temp. 450°F
Vap. Press. 10 mm @19.2°C
Vap. D. 3.86
Toxic Hazard Rating:
Acute Local: 0

Acute Systemic: Inhalation 2
Chronic Local: Irritant 1
Chronic Systemic: U
MAC: ACGIH (accepted); 500 parts per million in air; 2330 milligrams per cubic meter of air.
Caution: May act as a simple asphyxiant. See also Argon.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Severe, when exposed to heat or flame.
Explosive Range: 1.0 - 3.2%
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

OCTAPHENYL CYCLOTETRASILOXANE

Description: Crystals.
Formula: $[(C_6H_5)_2SiO]_4$
Constants:
  Mol. Wt. 793.12
  M. P. 202°C
  B. P. 335°C
Toxicity: Details unknown. See also Siloxanes.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

1-OCTENE

Synonyms: 1-Octylene; 1-caprylene.
Description: Colorless liquid.
Formula: C_8H_{16}
Constants: Flash P. 70°F (T.O.C.)
  Mol. Wt. 112.21
  M. P. −101.9°C
  B. P. 121.27°C
  Density 0.716 @20°/4°C
  Vap. D. 3.87
  Vap. Press. 36.2 mm @38°C
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

2-OCTENE

Description: Colorless liquid.
Formula: C_8H_{16}
Constants:
  Mol. Wt. 112.21
  M. P. −94.04°C
  B. P. 125.2°C
  Flash P. 70°F (T.O.C.)
  Density 0.7192 @20°/4°C
  Vap. D. 3.87
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

n-OCTYL ACETATE. See 2-Ethyl Hexyl Acetate.

OCTYL ALCOHOL

Synonyms: 1-Octanol; caprylic alcohol.
Description: Colorless liquid; penetrating aromatic odor.
Formula: Primary normal: $CH_3(CH_2)_6CH_2OH$
Constants:
  Mol. Wt. 130.23
  M. P. −16.3°C
  B. P. 195°C
  Flash P. 178°F
  Density 0.827 @20°/4°C
  Vap. D. 4.48
Toxicity: Details unknown. See also Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

OCTYL ALDEHYDE

Synonyms: 2-Ethylhexanal;

caprylaldehyde.
Description: Liquid.
Formula: $C_7H_{15}CHO$
Constants:
Mol. Wt. 128.2
B. P. 163.4°C
Flash P. 125°F (C.C.)
Density 0.821 @20°/4°C
Vap. D. 4.41
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

OCTYLAMINE

Description: Water-white liquid; amine-like odor.
Formula: $CH_3(CH_2)_7NH_2$
Constants:
Mol. Wt. 129.3
B. P. 170 - 179°C
Flash P. 140°F
Density 0.779 @20°/20°C
Vap. D. 4.46
Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

tert-OCTYLAMINE

Description: Clear liquid; amine-like odor.
Formula: $(CH_3)_3CCH_2C(CH_3)_2NH_2$
Constants:
Mol. Wt. 129.3
B. P. 140°C
Flash P. 92°F
Density 1.4213
Vap. D. 4.46
Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

OCTYL DECYL PHTHALATE

Description: A clear liquid.
Formula:
$C_6H_4(COOC_8H_{17})(COOC_{10}H_{21})$
Constants:
Mol. Wt. 418.6
B. P. 239°C @4 mm
Freezing P. -50°C
Flash P. 455°F (C.O.C.)
Density 0.980 @20°/20°C
Toxicity: Unknown. See Phthalic Acid.
Fire Hazard: Slight, when exposed to heat or powerful oxidizing agents (Section 6).
Storage and Handling: Section 7

OCTYLENE GLYCOL

Synonyms: 4,5-Octanediol.
Formula: $[CH_3(CH_2)_2CHOH]_2$
Constants: Mol. Wt. 146.2
M. P. 63°C
B. P. 475°F
Flash P. 230°F (C.C)
Density 0.94
Autoign. Temp. 635°F
Vap. D. 5.05
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

OCTYLENE GLYCOL BIBORATE

Description: A white solid.
Formula: $C_{24}H_{46}O_6B_2$
Constants: M. P. 69 - 104°C
Mol. Wt. 454.3
B. P. 154 - 173°F @0.4 mm
Toxicity: See Esters and Boron Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

OCTYL PHENOL
Synonym: Diisobutyl phenol.
Description: White or light pink flakes.
Formula:
$C_6H_4(C_8H_{17})OH$
Constants:
Mol. Wt. 206.3
B. P. 280 - 283°C
Freezing P. 72 - 74°C
Density 0.941 @24°/4°C
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of Phenol; can react with oxidizing materials.
Storage and Handling: Section 7

OCTYL SILICATE
Formula: $Si(OC_8H_{17})_4$
Constants:
Mol. Wt. 544.3
B. P. 204° @3 mm
Density 0.8208 @20°C
Toxicity: Details unknown; an insecticide.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

OCTYL TITANATE. See 2-Hexyl Ethyl Titanate.

OCTYL TRICHLOROSILANE
Description: Fuming liquid.
Formula: $C_8H_{17}SiCl_3$
Constant:
Mol. Wt. 247.7
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid; white label.
Coast Guard Classification; Corrosive liquid; white label.

OILED CLOTHING, FABRICS, RAGS, ETC.
Fire Hazard: Moderate, when exposed to heat or flame, by spontaneous chemical reaction or on contact with oxidizing materials (Section 6).
Spontaneous Heating: Yes, particularly when wet.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Hazardous article.

OIL GAS
Description: A gas derived from petroleum.
Composition: Illuminants 4.2%; carbon monoxide 10.4%; hydrogen 47.6%; methane 27.0%; carbon dioxide 4.6%; nitrogen 5.8%; oxygen 0.4%.
Constant:
Autoign. Temp. 637°F
Toxicity: Highly toxic. See Carbon Monoxide.
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or water spray (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.
Explosive Range: 6.0 - 13.5%
Disaster Control: Dangerous; shock can shatter the compressed gas container with explosive force; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

OIL, N.O.S.
Synonyms: Petroleum, crude oil.
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: U
Chronic Local: Irritant 1
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).

Disaster Control: Dangerous; keep away from open flame! It can react with oxidizing materials.
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Combustible liquid; inflammable liquid, red label.

OIL OF BITTER ALMOND

Description: Colorless to yellow liquid.
Composition: 95% Benzaldehyde, 2 - 4% HCN.
Constant:
Density 1.038-1.060 @25°/25°C
Toxicity: Highly toxic. See Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

OIL OF CHENOPODIUM

Synonym: Oil of American wormseed.
Description: Colorless or pale yellow liquid.
Composition: 60 - 70% Ascaridol
Constant:
Density 0.950-0.980 @25°/25°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3
Acute Systemic: Ingestion 3
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits irritant fumes (Section 6).
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

OIL OF CHERRY LAUREL

Description: Pale yellow liquid.
Composition: Hydrogen cyanide, benzaldehyde, benzaldehyde cyanhydrin, benzyl alcohol.
Density 1.054-1.066 @20°/20°C
Toxicity: Highly toxic. See Cyanides.
Disaster Control: Dangerous; when heated it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

OIL OF EUCALYPTUS

Description: Colorless to pale yellow liquid.
Composition: Eucalyptol, aldehydes, d-pinene.
Constants:
M. P. −15.4°C approx.
Density 0.905-0.925 @25°/25°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 1; Ingestion 2; Inhalation 1
Acute Systemic: U
Chronic Local: Allergen 1; Inhalation 2
Chronic Systemic: U
Disaster Control: Slight; when heated to decomposition it emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

OIL OF GARLIC

Composition: Allyl propyl disulfide, diallyl disulfide.
Constant:
Density 1.046-1.057 @15°/15°C
Toxicity: Details unknown. See individual components.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

OIL OF MIRBANE. See Nitrobenzene.

OIL OF PEPPERMINT

Description: Colorless to pale yellow liquid.
Constant:
Density 0.896-0.908 @25°/25°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

OIL OF TANSY

Description: Yellow liquid.

Composition: Thujone, borneol and camphor.
Constant:
Density 0.925-0.950 @15°/15°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1
Acute Systemic: Ingestion 3
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

OLEFINS

Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Inhalation 2
Chronic Local: U
Chronic Systemic: Inhalation 2
Toxicology: Unsaturated aliphatic hydrocarbons do not differ greatly from paraffins, particularly insofar as their toxic effect on working personnel is concerned. Ethylene and some of its homologues occur in manufactured and natural gases. Ethylene can be used as an anesthetic, and when inhaled in sufficient quantity it can be an asphyxiant. However, the greatest hazard from its use is the danger of fire and explosion. Prolonged or repeated exposures to high concentrations of various olefins have caused certain toxic effects in animals, such as liver damage and hyperplasia of the bone marrow (due to butene-2), but no corresponding effects have been discoverable in human beings as due to industrial exposures. The diolefins, butadiene and isoprene, are more irritating than paraffins or monoolefins of the same volatility. In general, it may be stated that the olefins are comparatively innocuous materials.
Ventilation Control (use normal rate): Section 2

OLEIC ACID

Synonym: Red oil (commercial grade).
Description: Colorless, odorless liquid when pure.
Formula: $C_{17}H_{33}COOH$
Constants:
Mol. Wt. 282.45
M. P. 14°C
B. P. 360.0°C
Flash P. 372°F (C.C.)
Density 0.895 @25°/25°C
Autoign. Temp. 685°F
Vap. Press. 1 mm @176.5°C
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: Ingestion 1
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

OLEO OIL

Description: Thick, yellow liquid.
Constants:
M. P. 2°F
B. P. 464°F
Flash P. 450°F (C.C.)
Density 0.915
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: Yes, on contact with fibrous combustible materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

OLEUM

Synonym: Fuming sulfuric acid.
Description: Heavy, fuming yellow liquid.
Formula: H_2SO_4 and up to 80% SO_3
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous, by chemical reaction with reducing agents and carbohydrates (Section 6).
Explosion Hazard: Severe, by chemical reaction with moisture and some organics.
Disaster Control: Dangerous; when heated to decomposition, it emits

highly toxic fumes of oxides of sulfur; will react with water or steam to produce heat and toxic and corrosive fumes; can react vigorously with reducing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

OLIVE OIL
Synonym: Sweet oil.
Description: Yellow oil.
Constants:
M. P. 21°F
Flash P. 437°F (C.C.)
Density 0.910
Autoign. Temp. 650°F
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: Some
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

"OMILITE"
Synonym: Polyethylene polysulfide.
Toxicity: Details unknown; a fungicide.
Fire Hazard: Details unknown. See also Sulfides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

OPIUM
Synonym: Gum opium.
Description: A habit-forming drug.
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Ingestion 3
Chronic Local: 0
Chronic Systemic: Ingestion 3
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

ORPIMENT. See Arsenic Sulfide.

OSMIC ACID ANHYDRIDE. See Osium Tetraoxide.

OSMIUM AND OSMIUM COMPOUNDS
Description: White, bluish metal.
Formula: Os
Constants:
At. Wt. 190.20
M. P. 2700°C
B. P. Above 5300°C
Density 22.48
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: Ingestion 1; Inhalation 1
Chronic Local: Irritant 2
Chronic Systemic: U
Toxicology: The principal effects of exposure are ocular disturbances and an asthmatic condition caused by inhalation. Furthermore, it causes dermatitis and ulceration of the skin upon contact (Section 9). When osmium is heated, it gives off a pungent, poisonous fume of osmium tetraoxide. One case of osmium poisoning reported in the literature resulted from the inhalation of osmium tetraoxide which gave rise to a capillary bronchitis and dermatitis. The vapor has a pronounced and nauseating odor which should be taken as a warning of the toxic concentration in the atmosphere, and personnel should immediately remove to an area of fresh air. Osmium compounds, other than the tetraoxide, are probably safe, particularly as ordinarily handled in industry. The metal itself is not highly toxic.
Radiation Hazard (Section 5): Artificial isotope Os^{191}, half-life: 16 days; emits beta particles of 0.14 mev and gamma rays of 0.13 mev. Artificial isotope Os^{193}, half-life 31 hours; emits beta particles of 1.15 mev, gamma rays of 1.6 mev and electron particles of 0.14 mev.
Fire Hazard: Moderate, in the form of dust, when exposed to heat or flame (Section 6).
Explosion Hazard: Slight, in the form of dust when exposed to heat or flame.
Personal Hygiene: Section 3

OSMIUM DICHLORIDE
Description: Dark brown, deliquescent crystals.
Formula: $OsCl_2$
Constants:
Mol. Wt. 261.11
M. P. Decomposes
Toxicity: See Osmium and Osmium Compounds.
Fire Hazard: Slight; when heated to decomposition, it emits toxic fumes of chlorides (Section 6).
Storage and Handling: Section 7

OSMIUM DISULFIDE
Description: Cubic, black crystals.
Formula: OsS_2
Constants:
Mol. Wt. 254.3
M. P. Decomposes
Toxicity: See Osmium and Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

OSMIUM HEXAFLUORIDE
Description: Green crystals.
Formula: OsF_6
Constants:
Mol. Wt. 304.20
M. P. > 50°C
B. P. 205°C
Toxicity: Probably toxic. See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

OSMIUM OCTAFLUORIDE
Description: Yellow crystals.
Formula: OsF_8
Constants:
Mol. Wt. 342.20
M. P. 34.4°C
B. P. 47.3°C
Toxicity: Probably toxic. See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

OSMIUM SULFITE
Description: Blue-black crystals.
Formula: $OsSO_3$
Constants:
Mol. Wt. 270.3
M. P. Decomposes
Toxicity: See Osmium and Sulfites.
Disaster Control: See Sulfites.
Storage and Handling: Section 7

OSMIUM TETRACHLORIDE
Description: Red-brown needles.
Formula: $OsCl_4$
Constants:
Mol. Wt. 332.03
M. P. Sublimes
Toxicity: See Hydrochloric Acid.
Disaster Control: See Chlorides.
Storage and Handling: Section 7

OSMIUM TETRAFLUORIDE
Description: Brown powder.
Formula: OsF_4
Constant:
Mol. Wt. 266.2
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

OSMIUM TETRAOXIDE
Synonym: Osmic acid.
Description: (A) Monoclinic, colorless crystals; (B) Yellow mass, pungent, chlorine-like odor.
Formula: OsO_4
Constants:
Mol. Wt. 254.20
M. P. A: 39.5°C B: 41°C
B. P. 130°C Sublimes
Density 4.906 @22°C
Vap. Press. A: 10 mm @26.0°C; B: 10 mm @31.3°C
Toxicity: Moderate. See Osmium.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

OSMIUM TETRASULFIDE
Description: Brown or black crystals.
Formula: OsS_4
Constants:
Mol. Wt. 318.4
M. P. Decomposes
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

OSMIUM TRICHLORIDE
Description: Cubic, brown crystals.
Formula: $OsCl_3$
Constants:
Mol. Wt. 296.57
M. P. Decomposes @560 - 600°C
Toxicity: See Osmium and Chlorides.

Disaster Control: See Chlorides.
Storage and Handling: Section 7

OXALATES

Formula: Salts of oxalic acid.
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3
  Acute Systemic: Ingestion 3
  Chronic Local: Irritant 1
  Chronic Systemic: Ingestion 1
Toxicology: Oxalates are corrosive and produce local irritation. When taken by mouth they have a caustic effect on the mouth, esophagus and stomach. The soluble oxalates are readily absorbed from the gastro-intestinal tract and can cause severe damage to the kidneys.
Disaster Control: Dangerous; when heated to decomposition, they emit toxic fumes.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

OXALIC ACID

Synonym: Ethanedioic acid.
Description: Transparent, colorless crystals.
Formula: $COOHCOOH \cdot 2H_2O$
Constants:
  Mol. Wt. 126.1
  M. P. 101°C; 189°C (anh.)
  B. P. Subl. @ 150°C
  Density 1.653
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: Irritant 3; Ingestion 3; Inhalation 3
  Chronic Systemic: Ingestion 2; Inhalation 2
Toxicology: Acute oxalic poisoning results from ingestion of a solution of the acid. There is marked corrosion of the mouth, esophagus and stomach, with symptoms of vomiting, burning abdominal pain, collapse and sometimes convulsions. Death may follow quickly. The systemic effects are attributed to the removal by the oxalic acid of the calcium in the blood. The renal tubules become obstructed by the insoluble calcium oxalate, and there is profound kidney disturbance. The inhalation of the dust or vapor may cause symptoms of irritation of the upper respiratory tract, gastro-intestinal disturbances, albuminuria, gradual loss of weight, increasing weakness and nervous system complaints. Oxalic acid has a caustic action on the skin and may cause dermatitis (Section 9); a case of early gangrene of the fingers resembling that caused by phenol has been described.

The chief effects of inhalation of the dusts or vapor are irritation of the eyes and upper respiratory tract, ulceration of the mucous membrane of the nose and throat, epistaxis, headache, irritability and nervousness. More severe cases may show albuminura, chronic cough, vomiting, pain in the back and gradual emaciation and weakness. The skin lesions are characterized by cracking and fissuring of the skin and the development of slow-healing ulcers. The skin may be bluish in color, and the nails brittle and yellow.

Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

OXALYL BROMIDE

Synonym: Ethanedioyl bromide.
Description: A liquid.
Formula: $(COBr)_2$
Constant:
  Mol. Wt. 215.85
Toxicity: Highly toxic. See Oxalic Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromides; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

OXALYL CHLORIDE
Synonym: Ethanedioyl chloride.
Description: Colorless, fuming liquid.
Formula: COClCOCl
Constants: Mol. Wt. 126.93
M. P. -12°C
B. P. 64°C
Density 1.488 @ 13°C
Toxicity: Highly toxic. See Oxalic Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

N-OXYDIETHYLENE BENZOTHIAZOLE-2-SULFENAMIDE
Description: Tan-colored powder.
Formula: $C_6H_4SNCSN(CH_2)_4O$
Constants:
Mol. Wt. 252.4
M. P. 90°C
Density 1.37
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur and oxides of nitrogen.
Storage and Handling: Section 7

β,β'-OXYDIPROPIONITRILE
Description: Colorless liquid.
Formula: $O(CH_2CH_2CN)_2$
Constants:
Mol. Wt. 124.1
M. P. -26.3°C
B. P. 172°C @10 mm
Density 1.041 @30°C
Toxicity: Highly toxic. See Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

OXIDIZING MATERIALS, N.O.S.
Shipping Regulations: Section 11.
I.C.C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

OXYGEN
Description: Colorless, odorless, tasteless gas or liquid or hexagonal crystals.
Formula: O_2
Constants:
Mol. Wt. 32.00
M. P. -218.4°C
B. P. -183.0°C
Density Liquid: 1.14 @-183.0°C
Solid: 1.426 @-252.5°C
Vap. D. 1.429 @0°C
Toxicity: None, as gas. In liquid form it can cause severe "burns" and tissue damage on contact with the skin.
Fire Hazard: Though itself nonflammable, it is essential to combustion. Exclusion of oxygen from the neighborhood of a fire is one of the principle methods of extinguishment. See Section 6 for details.
Explosion Hazard: Liquid oxygen can explode on contact with readily oxidizable material, especially at high temperature.
Disaster Control: Compressed oxygen is shipped in steel cylinders under high pressure. If these containers are broken due to shock or exposed to high temperature, an explosion or fire may result.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Nonflammable gas; green gas label.
Coast Guard Classification: Nonflammable gas; green gas label.

OXYGEN FLUORIDE
Description: Colorless gas.
Formula: OF_2
Constants:
Mol. Wt. 54.0
M. P. -223.8°C
B. P. -144.8°C
Density Liquid: 190 @-223.8°C
Toxicity: See Fluorides and Hydrofluoric Acid.
Fire Hazard: Dangerous, by chemical reaction with reducing agents (Section 6).
Explosion Hazard: Moderate, by chemical reaction with powerful reducers.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of fluorides; will react with water, steam or acids to produce toxic and corrosive fumes; can react

vigorously with reducing materials.
Storage and Handling: Section 7

OXYGEN, LIQUID. See Explosives, High.

8-OXYQUINOLINE BENZOATE
Toxicity: Details unknown; a fungicide.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

OZOKERITE
Synonym: Mineral wax.
Constants:
M. P. 136 - 230°F
Flash P. 236°F (C.C.)
Density 0.85 - 0.95
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

OZONE
Description: Colorless gas or dark blue liquid.
Formula: O_3
Constants:
Mol. Wt. 48.00
M. P. -251°C
B. P. -111.1°C
Density Gas: 2.144 g/l;
Liquid: 1.71 @ -183°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Inhalation 3
Acute Systemic: Inhalation 3
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (accepted); 0.1 part per million in air; 0.2 milligrams per cubic meter of air.
Toxicology: Ozone has a strong irritant action on the upper respiratory system. Concentrations of 0.015 parts of ozone per million parts of air produce a barely detectable odor. Concentrations of 1 ppm produce a disagreeable sulfur-like odor and may cause headache and irritation of the upper respiratory tract which disappear after leaving the exposure. Exposure of guinea pigs to higher concentrations may cause death from lung congestion and edema. No systemic effects have been reported following industrial exposures.
Fire Hazard: Dangerous, by chemical reaction with reducing agents or combustibles (Section 6).
Explosion Hazard: Severe, when shocked, exposed to heat or flame or by chemical reaction with powerful reducing agents.
Disaster Control: Dangerous; shock or heat can shatter the compressed gas container with explosive force.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

OZONIZED ETHER
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame or by chemical reaction with reducing agents (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7

P

PAINT

Description: A fluid mixture of a pigment and a vehicle.
Constant:
Flash P. 0 - 80 °F
Toxicity: For lead-base paints, see Lead; usually the toxicity is that of the solvent used.
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: Yes
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated, the solvent emits acrid fumes; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Combustible liquid.

PAINT AND GREASE ERADICATORS

Constant:
Flash P. 0 - 80 °F
Toxicity: Variable.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

PAINT SCRAPINGS

Toxicity: Variable.
Fire Hazard: Moderate, when exposed to heat or flame; avoid large unventilated piles. Danger of heating depends upon state of dryness (Section 6).
Spontaneous Heating: Moderate.

PALLADIUM BROMIDE

Description: Red-brown crystals.
Formula: $PdBr_2$
Constants: Mol. Wt. 266.53
M. P. Decomposes
Toxicity: See Palladium Compounds.

PALLADIUM COMPOUNDS

Toxicity: Low. This metal, in the form of palladium chloride, has been administered orally in dosage of about 1 grain daily in the treatment of tuberculosis. These amounts resulted in no toxic effects. Applied locally to the skin, palladium chloride shows little or no irritation. In experimental animals, palladium chloride has been given by intravenous injection, producing damage to bone marrow, liver and kidneys when the dosage was of the order of 0.5 to 1.0 mg per kg of body weight.
Radiation Hazard (Section 5): Artificial isotope Pd^{109}, half-life: 13 hours; emits beta particles of 0.98 mev.
Fire Hazard: Slight, in the form of dust, when exposed to heat or flame (Section 6).

PALLADIUM CYANIDE

Description: Yellowish-white crystals.
Formula: $Pd(CN)_2$
Constants:
Mol. Wt. 158.74
M. P. Decomposes
Toxicity: Highly toxic. See also Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

PALLADIUM DIFLUORIDE
Description: Brown crystals.
Formula: PdF_2
Constants:
  Mol. Wt. 144.70
  M. P. Volatilizes
  B. P. Decomp. @red heat.
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

PALLADIUM HYDRIDE
Description: Silver, metallic crystals.
Formula: Pd_2H
Constants:
  Mol. Wt. 428.82
  M. P. Decomposes
  Density 10.76
Toxicity: See Hydrides.
Fire Hazard: See Hydrides.
Explosion Hazard: See Hydrides.
Disaster Control: See Hydrides.
Storage and Handling: Section 7

PALLADIUM IODIDE
Description: Black powder.
Formula: PdI_2
Constants:
  Mol. Wt. 360.54
  M. P. Decomp. @350°C
Toxicity: See Palladium Compounds.

PALLADIUM MONO- AND DISULFIDES
Description: Brown-black crystals.
Formula: PdS, PdS_2
Constants:
  Mol. Wt. 138.8; 170.8
  M. P. Decomp. @950°C
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

PALLADIUM NITRATE
Description: Rhombic, brown-yellow deliquescent.
Formula: $Pd(NO_3)_2$
Constants: Mol. Wt. 230.72
  M. P. Decomposes
Toxicity: See Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

PALLADIUM SELENIDE
Description: Dark gray crystals.
Formula: $PdSe$
Constants:
  Mol. Wt. 185.66
  M. P. < 960°C
Toxicity: Probably high. See Selenium Compounds.
Fire Hazard: See Hydrogen Selenide.
Explosion Hazard: See Hydrogen Selenide.
Disaster Control: See Hydrogen Selenide.
Storage and Handling: Section 7

PALLADIUM SUBSULFIDE
Description: Green-gray crystals.
Formula: Pd_2S
Constants:
  Mol. Wt. 245.47
  M. P. Decomp. @800°C
  Density 7.303 @15°C
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

PALM KERNEL OIL
Synonym: Palm nut oil.
Constants:
  M. P. 25.5 - 30°C
  Flash P. 398°F (C.C.)
  Density 0.95
Toxic Hazard Rating:
  Acute Local: Irritant 1; Allergen 1
  Acute Systemic: 0
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight; when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: Yes
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

PALM OIL
Synonym: Palm butter.
Description: Reddish-yellow to dirty-red, fatty mass; faint odor of violet.
Composition: Palmitin, stearin, linolein.

Constants:
M. P. 26.6 - 43.3°C
Flash P. 421°F (C.C.)
Density 0.92
Autoign. Temp. 600°F
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: 0
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: Yes, low.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

PAPAVERINE

Description: Colorless, rhombic needles.
Formula: $C_{20}H_{21}NO_4$
Constants: Mol. Wt. 339.38
M. P. 147°C
B. P. Decomposes
Density 1.337
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3
Chronic Local: U
Chronic Systemic: Ingestion 1; Inhalation 1
Toxicology: This material is considered to be a comparatively weak poison. Its action on the central nervous system is about midway between morphine and codeine and even large doses do not produce the amount of excitement caused by codeine or the soporific action of morphine. Small doses are followed by sleep and slow respiration, but these are not increased with larger doses. The heart beat is slowed, but the blood pressure is scarcely affected. It is thought that doses up to 15 grains are nonfatal. See also Morphine.
Fire Hazard: Slight; when heated, it emits toxic fumes (Section 6).
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

PAPER STOCK, WET. See Waste Paper, Wet.

PARAFFIN OILS

Description: The color range is from pale yellow through yellowish-brown to reddish-brown to dark green.
Constant:
Flash P. 444°F
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: 0
Chronic Local: Irritant 1
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

PARAFFINS

Toxicity: The effects of the paraffin hydrocarbons vary with the volatility. The gaseous hydrocarbons, such as methane, ethane, etc., have but slight anesthetic effect and are hazardous only when present in sufficient concentration to dilute the oxygen to a point below that which is necessary to sustain life. With the volatile liquid hydrocarbons, or with the next higher fraction, the anesthetic action predominates, and with the higher molecular weights or with the less volatile compounds, the anesthetic increases, but at the same time an irritant action becomes more pronounced. For information concerning the toxic and hazardous properties of these materials, see the individual compounds.

PARAFFIN WAX

Description: Colorless or white, somewhat translucent, odorless, mass; greasy feel.
Constants:
M. P. 43.3 - 60°C
B. P. Above 370°C
Flash P. 390°F (C.C.)
Density 0.9
Autoign. Temp. 473°F
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: 0
Chronic Local: Irritant 1

Chronic Systemic: 0

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

Spontaneous Heating: No

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Personal Hygiene: Section 3

Storage and Handling: Section 7

PARAFORMALDEHYDE

Synonyms: Polyoxymethylene glycol; paraform.

Description: White powder.

Formula: $(CH_2O)_xHOH$

Constants:

M. P. 120 - 160°C (sealed tube)

B. P. Vaporizes, depolymerizing to formaldehyde gas.

Flash P. 200°F (T.O.C.)

Density 1.39

Autoign. Temp. 572°F

Vap. Press. 1.45 mm @25°C

Toxic Hazard Rating:

Acute Local: Irritant 2; Ingestion 2; Inhalation 2

Acute Systemic: Ingestion 2

Chronic Local: U

Chronic Systemic: Ingestion 1

Fire Hazard: Moderate, when exposed to heat or flame.

Spontaneous Heating: No

To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Disaster Control: Moderately dangerous; when heated, it forms formaldehyde gas and oxides of carbon; can react with oxidizing materials.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

MCA warning label.

PARALDEHYDE

Synonyms: Para-acetaldehyde; 2, 4, 6 trimethyl-1, 3, 5 trioxane.

Description: Colorless liquid.

Formula:

$OCH(CH_3)OCH(CH_3)OCHCH_3$

Constants:

Mol. Wt. 132.16

M. P. 12.6°C

B. P. 124.4°C @752 mm

Flash P. 63°F (C.C.)

Density 0.9943 @20°/4°C

Autoign. Temp. 460°F

Vap. D. 4.55

Toxic Hazard Rating:

Acute Local: Irritant 1

Acute Systemic: Ingestion 2; Inhalation 2

Chronic Local: U

Chronic Systemic: Ingestion 1; Inhalation 1

Toxicology: Paraldehyde has hypnotic and analgesic properties. However, poisoning due to it is very rare. There is a wide range between the hypnotic dose and the toxic dose; 2 to 5 grams produces a soporific effect; recovery has been observed following the ingestion of 50 grams. Continued use of the drug has been known to result in habituation. There have been no cases reported of industrial poisoning.

Signs and symptoms are incoordination and drowsiness, followed by sleep. With larger doses, the pupils dilate, reflexes are lost, and patient lapses into coma. Weak pulse and shallow respiration are followed by cyanosis. Death results from respiratory paralysis.

The symptoms of chronic intoxication from this material are disturbances of the digestion, continual thirst, general emaciation, muscular weakness and mental failure followed by tremors of the hands and tongue. It can cause skin eruptions similar to those caused by chloral hydrate (Section 9).

Treatment and Antidotes: When a toxic dose of this material has been ingested, wash out the stomach and give barbiturates or morphine to quiet the nerves. Call a physician.

Fire Hazard: Dangerous, when exposed to heat or flame.

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Slight, when exposed to heat or flame.

Explosive Range: 1.3% (L.E.L.)

Disaster Control: Dangerous; keep away from heat and open flame; emits toxic fumes on heating;

can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  Coast Guard Classification: Combustible liquid
  MCA warning label

PARATHION

Synonyms: O,O-Diethyl O-p-nitrophenyl thiophosphate.
Description: Yellowish liquid.
Formula: $C_{10}H_{14}NO_5PS$
Constants:
  Mol. Wt. 291.3
  B. P. 375°C
  Density 1.26 @25°/4°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
  Chronic Local: U
  Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3

Toxicology: Parathion, like the other organic phosphorus poisons, acts as an irreversible inhibitor of the molecules of the enzyme cholinesterase and thus allows the accumulation of large amounts of acetylcholine. When a critical level of cholinesterase depletion is reached, grave symptoms appear. Whether death is actually caused entirely by cholinesterase depletion or by the disturbance of a number of enzymes is not yet known. Recovery is apparently complete if a poisoned animal or man has time to reform his critical quota of cholinesterase. However, if a second small dose is administered before recovery from the first is complete, the effect is partially additive.

Dangerous Acute Dose in Man: Death has followed splashing of the body and clothing of one worker with technical parathion (approximately 95 percent pure). The amount was sufficiently small that the worker was not soaked or at any rate did not follow the simple instructions for changing clothes and bathing. Two operators have died after rather extensive skin contact with agricultural sprays and the inhalation of dust from 25-percent water-wettable powder. Others have died after what was apparently almost entirely respiratory exposure to 25-percent dust. In no single case of fatal human poisoning by parathion has it been possible to determine the exact dosage which the victim received either on the day on which symptoms appeared or subacutely over a period of days or weeks. However, on the basis of animal experiments the acute lethal oral dose for man has been estimated at 10 to 20 mg ($\frac{1}{5}$ to $\frac{1}{3}$ grains). Based again on animal experiments the acute lethal dose by the dermal route would be only about three times as great.

Dangerous Chronic Dose in Man: Exposure to parathion reduces the cholinesterase level and the organism exposed remains susceptible to relatively low dosages of parathion until the cholinesterase level has regenerated. Small doses at frequent interval are, therefore, more or less additive. There is, however, at the present time no indication that, when recovery from a given exposure is entirely complete, the exposed organism is prejudiced in any way.

Symptoms of Poisoning: Headache, giddiness, blurred vision, weakness, nausea, cramps, diarrhea, and discomfort in the chest, sweating, miosis, tearing, salivation, pulmonary edema, cyanosis, papilledema, convulsions, coma, and loss of reflexes and sphincter control. The last several signs are seen only in advanced cases but do not preclude a favorable outcome if energetic treatment is continued. Poisoned animals show various degrees of heart block and cardiac arrest may occur. In most cases of accidental, chiefly dermal exposure, relatively incapacitating symptoms of nausea, cramps, muscular twitching, etc., follow the initial giddiness, blurred vision, and pin-point pupils only

after a period of 2 to 8 hours. In one such case, the onset of serious symptoms was apparently more rapid. Following oral ingestion associated with murder or suicide, death has been esentially instantaneous.
MAC: ACGIH (accepted); 0.1 milligram per cubic meter of air.
Disaster Control: Highly dangerous; shock can shatter the container, releasing the contents when heated to decomposition, it emits highly toxic fumes of nitrogen oxides, phosphorus and sulfur.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  Coast Guard Classification: Poison B; poison label.
  MCA warning label.

PARATHION AND COMPRESSED GAS MIXTURES.
See Parathion.
Shipping Regulations: Section 11.
  I.C.C. Classification: Poison A; poison gas label.
  Coast Guard Classification: Poison A; poison gas label.

PARIS GREEN
Synonym: Copper acetoarsenate.
Description: Emerald green powder.
Formula: Approx. $Cu(C_2H_3O_2)_2 \cdot 3CuO \cdot As_2O_3$
Constant:
  Mol. Wt. 1013.83
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.
  MCA warning label

PEANUT OIL
Synonyms: Katchung oil; earthnut oil.
Description: Straw-yellow to greenish-yellow or nearly colorless oil; nutty odor and bland taste.
Constants:
  M. P. 2.7°C
  Flash P. 540°F
  Density 0.92
  Autoign. Temp. 833°F
Toxic Hazard Rating:
  Acute Local: Irritant 1; Allergen 1
  Acute Systemic: 0
  Chronic Local: Irritant 1; Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: Slight.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

PEANUT RED SKIN
Description: A red skin-like layer between nut and shell.
Toxic Hazard Rating:
  Acute Local: Irritant 1; Allergen 1; Inhalation 1
  Acute Systemic: Ingestion 1; Inhalation 1
  Chronic Local: Irritant 1; Allergen 1; Inhalation 1
  Chronic Systemic: Ingestion 1; Inhalation 1
Fire Hazard: Moderate, by chemical reaction; can react with oxidizing materials (Section 6).
Spontaneous Heating: High
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

PENTABORANE, STABLE
Synonyms: Pentaboron enneahydride.
Description: Colorless gas or liquid; bad odor.
Formula: B_5H_9
Constants:
  Mol. Wt. 63.2
  M. P. −46.6°C.
  B. P. 0°C @ 66 mm
  Density 0.61 @ 0°C
  Vap. Press. 66 mm @ 0°C
  Vap. D. 2.2
Toxicity: See Boron Hydrides.
Fire Hazard: Dangerous, by chemical reaction; spontaneously

flammable in air (Section 6).
Explosion Hazard: Dangerous. Details unknown.
Disaster Control: Dangerous; on decomposition, it emits toxic fumes and can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

PENTABORANE, UNSTABLE

Synonyms: Dihydropentaborane.
Description: Colorless liquid; turns yellow on standing.
Formula: B_5H_{11}
Constants:
Mol. Wt. 65.2
B. P. 63°C
Toxicity: See Boron Hydrides.
Fire Hazard: Dangerous, by chemical reaction; ignites spontaneously in air (Section 6).
Explosion Hazard: Dangerous. Details unknown.
Disaster Control: Dangerous; on decomposition, it emits highly toxic fumes; can react vigorously with oxidizing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label, not accepted.

"PENT-ACETATE"

Composition: A mixture of amyl acetates and amyl alcohols.
Description: Colorless liquid; agreeable odor.
Constants:
B. P. 125°C
Flash P. 90°F (C. C.)
Density 0.864
Autoign Temp. 110°F
Toxicity: Moderate. See Amyl Alcohol and Amyl Acetate.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Combustible liquid.

PENTACHLOROETHANE

Synonym: Pentalin.
Description: Colorless liquid.
Formula: $CHCl_2CCl_3$
Constants:
Mol. Wt. 202.3
M. P. −29°C
B. P. 162°C
Density 1.6728 @25°/4°C
Vap. Press. 10 mm @39.8°C
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, by spontaneous chemical reaction. Dehalogenation by reaction with alkalies, metals, etc., will produce spontaneously explosive chloroacetylenes.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

PENTACHLOROETHYL BENZENE

Description: White, crystalline solid.
Formula: $Cl_5C_6CH_2CH_3$
Constants:
Mol. Wt. 278.4
M. P. 53.4°C
B. P. 305°C
Density 1.552 @60°/25°C
Vap. Press. 1 mm @96.2°C
Vap. D. 9.6
Toxicity: Unknown.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

PENTACHLOROMETHYL ETHER

Description: Liquid.
Formula: CCl_3OCHCl_2
Constants:
  Mol. Wt. 218.32
  B. P. 158.5 to 159.5°C
  Density 1.64 @20°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PENTACHLORONAPHTHALENE

Description: White solid.
Formula: $C_{10}H_3Cl_5$
Constant:
  Mol. Wt. 300.41
Toxic Hazard Rating:
  Acute Local: Irritant 2
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: Irritant 2
  Chronic Systemic: Ingestion 3; Inhalation 3
MAC: ACGIH (accepted); 0.5 milligrams per cubic meter of air.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PENTACHLORONITROBENZENE

Description: A solid.
Formula: $C_6Cl_5NO_2$
Constant:
  Mol. Wt. 295.4
Toxicity: Details unknown; probably quite toxic; an insecticide. See Nitro Compounds of Aromatic Hydrocarbons.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of nitrogen.
Storage and Handling: Section 7

PENTACHLOROPHENOL

Description: Dark-colored flakes and sublimed needle crystals with a characteristic odor.
Formula: Cl_5C_6OH
Constants:
  Mol. Wt. 266.4
  M. P. 191°C
  B. P. 310°C (decomposes)
  Density 1.978
  Vap. Press. 40 mm @211.2°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
  Chronic Local: Irritant 2
  Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
MAC: ACGIH (accepted); 0.5 milligrams per cubic meter of air.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
MCA warning label required.

3-PENTADECYL PHENOL

Description: Flaked pink to white waxy solid.
Formula: $C_{15}H_{31}C_6H_4OH$
Constants:
  Mol. Wt. 304.5
  M. P. 49° - 51°C
  Density < 1
  B. R. 190 - 195°C @1 mm
Toxicity: Details unknown. See also Phenol.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits acrid fumes; can react with oxidizing materials.
Storage and Handling: Section 7

5-PENTADECYL RESORCINOL
Description: Pale amber to white crystalline solid.
Formula: $C_{15}H_{31}C_6H_3(OH)_2$
Constants:
Mol. Wt. 320.5
M. P. 91 - 93°C
B. P. 220 - 225°C @1 mm
Density > 1
Toxicity: Details unknown; a weak allergen.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

PENTAERYTHRITOL DIACETAL
Description: White flakes.
Formula: $C(CH_2O)_4(CHCH_3)_2$
Constants:
Mol. Wt. 188.22
M. P. 42°C
B. P. 216°C
Toxicity: Unknown.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

PENTAERYTHRITOL DIBUTYRAL
Description: White flakes.
Formula: $C(CH_2O)_4(CHC_3H_7)_2$
Constants:
Mol. Wt. 244.3
M. P. 59°C
B. P. 290°C
Toxicity: Unknown.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

PENTAERYTHRITOL DIFORMAL
Description: White flakes.
Formula: $C(CH_2O)_4(CH_2)_2$
Constants:
Mol. Wt. 160.17
M. P. 50°C
B. P. 80 - 83°C @1 mm
Toxicity: Unknown.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

PENTAERYTHRITOL DIPROPIONAL
Description: Slightly viscous, colorless liquid.
Formula: $C(CH_2O)_4(CHC_2H_5)_2$
Constants:
Mol. Wt. 216.3
M. P. 19°C
B. P. 259°C
Vap. D. 7.47
Toxicity: Unknown.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

PENTAERYTHRITOL, TECHNICAL
Synonyms: Pentek; penetek.
Description: Crystalline material.
Formula: $C(CH_2OH)_4$
Constants:
Mol. Wt. 136.1
M. P. 262°C
Density 1.38 @25°/4°C
Toxicity: Unknown.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

PENTAERYTHRITOL TETRANITRATE
Synonym: PETN
Description: Crystals.
Formula: $C(CH_2NO_3)_4$
Constants:
Mol. Wt. 316.55
M. P. 138 - 140°C
B. P. Explodes @205 - 215°C
Density 1.773 @20°/4°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: See Nitrates.
Explosion Hazard: Severe, when shocked or exposed to heat. One of the most powerful high explosives, it is particularly sensitive to shock. It is used in detonating and priming compositions, as a base-charge in anti-aircraft shells and mixed with TNT (70 - 30) in mines, explosive bombs and torpedoes. It is a very effective demolition explosive. It is also used in blasting caps combined with lead azide and diazodinitrophenol. It explodes at 215°C (See Explosives, High).

Disaster Control: Highly dangerous; shock or heat will explode it; on decomposition, it emits highly toxic fumes of oxides of nitrogen; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: A explosive; not accepted by express. Initiating explosive label.

"PENTALARM"

Composition: Mixture of isomeric amyl mercaptans.
Description: A liquid.
Constants:
B. P. 100°C
Flash P. 63°F (O. C.)
Density 0.83 - 0.85
Toxic Hazard Rating:
Acute Local: Irritant 2; Inhalation 2
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown.
Disaster Control: Dangerous, keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PENTAMETHYLENE DIAMINE

Synonym: Cadaverine.
Description: Colorless, thick liquid; characteristic odor.
Formula: $C_5H_{14}N_2$
Constants:
Mol. Wt. 102.2
M. P. 9°C
B. P. 178 - 180°C
Density 0.873 @25°/4°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of nitrogen compounds and cyanides.
Personal Hygiene: Section 3
Storage and Handling: Section 7

PENTAMETHYLENE OXIDE

Synonym: Tetrahydropyran.
Description: A liquid.
Formula: $C_5H_{10}O$
Constants:
Mol. Wt. 86.1
B. P. 81.1°C
Flash P. −4°F
Density 0.854
Vap. D. 3.0
Toxicity: Unknown.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown.
Disaster Control: Dangerous. Keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

n-PENTANE

Synonym: Amyl hydride.
Description: Colorless liquid.
Formula: $CH_3(CH_2)_3CH_3$
Constants:
Mol. Wt. 72.15
B. P. 36.1°C
Flash P. −56.6°F (C. C.)
Freezing P. −129.8°C
Density 0.626 @20°/4°C
Autoign Temp. 588°F
Vap. Press. 400 mm @18.5°C
Vap. D. 2.48
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Inhalation 1
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (accepted); 1000 parts per million in air; 2940 milligrams per cubic meter of air.
Fire Hazard: Highly dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Severe, when

exposed to heat or flame.
Explosive Range: 1.4% - 8.0%.
Disaster Control: Highly dangerous; keep away from heat, sparks or open flame; shock can shatter metal containers and release contents.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

1, 5-PENTANEDIOL

Synonyms: Pentamethylene glycol.
Description: Colorless, viscous, odorless liquid.
Formula: $HOCH_2CH_2CH_2CH_2CH_2OH$
Constants: Mol. Wt. 104.15
B. P. 242.5°C
Flash P. 275°F
Freezing P. −15.6°C
Density 0.994 @20°/4°C
Vap. Press. < 0.01 mm @20°C
Vap. D. 3.59
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

PENTANEDIONE-2, 4

Synonym: Acetylacetone.
Description: Colorless liquid.
Formula: $CH_3COCH_2COCH_3$
Constants:
Mol. Wt. 100.11
M. P. −23.2°C
B. P. 139°C @746 mm
Flash P. 105°F (O. C.)
Density 0.976
Vap. D. 3.45
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

PENTANICKEL DIPHOSPHIDE

Description: Needles, tablets or crystals.
Formula: Ni_5P_2
Constants: Mol. Wt. 355.41
M. P. 1185°C
Toxicity: See Nickel Compounds and Phosphine.
Fire Hazard: Moderate; see also Phosphine.
Explosion Hazard: Moderate. See also Phosphine.
Disaster Control: Dangerous; see Phosphine.
Storage and Handling: Section 7

PENTANONE-2

Synonym: Methyl propyl ketone.
Description: Colorless liquid.
Formula: $CH_3CO(CH_2)_2CH_3$
Constants:
Mol. Wt. 86.13
B. P. 102.3°C
Flash P. 72°F (O. C.)
Freezing P. −77.5°C
Density 0.812 @15°/15°C
Vap. Press. 26.9 mm @20°C
Vap. D. 2.96
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: Inhalation 2
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (accepted); 200 parts per million in air; 704 milligrams per cubic meter of air.
Toxicology: The irritant action of pentanone in relation to its narcotic action is more marked than in the case of the lower ketones, acetone and butanone. Concentrations of 1,500 ppm of pentanone are irritant to the eyes and nose after several hours exposure. See also Acetone and Butanone.
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry

chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 1.55 - 8.15%
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

"PENTASOL"

Description: Liquid.
Composition: A mixture of isomeric amyl alcohols.
Constants: B. P. 108 - 140°C
 Flash P. 113°F (O. C.)
 Density 0.81 - 0.82
Toxic Hazard Rating:
 Acute Local: Irritant 2; Ingestion 2; Inhalation 2
 Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
 Chronic Local: U
 Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PENTATHIONIC ACID

Toxicity: Details unknown; a fungicide.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

PENTATRIACONTENE

Description: A white solid.
Formula: $C_{17}H_{35}CHCHC_{16}H_{33}$
Constants: Mol. Wt. 491.0
 B. P. 260 - 265°C @0.5 mm
 Flash P. 239°F (O. C.)
 M. P. 75°C
 Density 0.8
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

1-PENTENE

Synonym: Propyl ethylene.
Description: Liquid.
Formula: $CH_3CH_2CH_2CHCH_2$
Constants: Mol. Wt. 70.1
 B. P. 30.1°C
 Freezing P. −138°C
 Flash P. < 20°F
 Density 0.6409 @20°/4°C
 Vap. Press. 400 mm @12.8°C
 Vap. D. 2.41
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

2-PENTENE

Synonym: sym-Methylethylethylene.
Description: Liquid.
Formula: C_5H_{10}
Constants:
 Mol. Wt. 70.1
 M. P. Cis: −179°C; trans: −135°C
 B. P. Cis: 37°C; trans: 35.85°C
 Flash P. 0°F
 Density Cis form: 0.6503 @20°/4°C; trans form: 0.6482 @20°/4°C
 Vap. D. 2.41
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate

rate): Section 2
Storage and Handling: Section 7

3-PENTENE-2-ONE
Synonyms: Ethylidene acetone; methylvinyl ketone.
Description: Colorless liquid.
Formula: $CH_3CHCHCOCH_3$
Constants:
Mol. Wt. 84.11
B. P. 122 - 124°C
Density 0.856
Vap. D. 2.89
Toxic Hazard Rating: (based on test animals)
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PEPPERMINT OIL. See Oil of Peppermint.

PERACETIC ACID (40% SOLUTION)
Synonyms: Peroxyacetic acid; acetyl hydroperoxide.
Description: Colorless liquid; strong odor.
Formula: CH_3COOOH
Constants:
Mol. Wt. 76.05
B. P. 105°C; explodes @110°C
Flash P. 105°F (O. C.)
Density 1.15 @20°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: See Peroxides, Organic.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 7).
Explosion Hazard: Moderate, when exposed to heat or by spontaneous chemical reaction. A powerful oxidizing agent.
Explosive Range: @110°C (pure material).
Disaster Control: Dangerous; keep away from combustible materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

PERBENZOIC ACID
Synonym: Benzoyl hydroperoxide.
Description: Leaflets.
Formula: C_6H_5COOOH
Constants:
Mol. Wt. 138.1
M. P. 42°C
B. P. Explodes @80 - 100°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: A powerful oxidizing agent. See Peroxides, Organic.
Explosion Hazard: Severe, when exposed to heat or flame.
Explosive Range: @80 - 100°C
Disaster Control: Dangerous; heat will cause it to explode; can react vigorously with reducing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PERCHLORATES
Composition: Combinations of a metal and the mono-valent $^-ClO_4$ radical.
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2
Chronic Local: U
Chronic Systemic: Ingestion 2

Toxicology: Perchlorates are unstable materials, and are irritating to the skin and mucous membranes of the body wherever they come in contact with it. Avoid skin contact with these materials (Section 9).
Fire Hazard: Moderate, by chemical reaction; powerful oxidizers. See also Explosives, High.
To Fight Fire: Water or foam (Section 6).
Explosion Hazard: Moderate, when shocked, exposed to heat or by chemical reaction. Perchlorates, when mixed with carbonaceous material, form explosive mixtures. They are considered a fire and explosive hazard when associated with carbonaceous materials or finely divided metals. This is also true of the presence of sulfur, powdered magnesium and aluminum. See Explosives, High, and Section 7.
Disaster Control: Dangerous; shock will explode them; when heated, they emit highly toxic fumes of chlorides; they can react with reducing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Oxidizing material; yellow label.
  Coast Guard Classification: Oxidizing material; yellow label.

PERCHLORIC ACID

Description: Colorless, fuming, unstable liquid.
Formula: $HClO_4$
Constants:
  Mol. Wt. 100.47
  M. P. −112°C
  B. P. 19°C @11 mm
  Density 1.768 @22°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: Irritant 2; Inhalation 2
  Chronic Systemic: U
Fire Hazard: See Perchlorates.
Explosion Hazard: See Perchlorates.
Disaster Control: See Perchlorates.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
MCA warning label

PERCHLORIC ACID, MONOHYDRATE

Synonym: Hydronium perchlorate.
Description: Fairly stable needles.
Formula: $HClO_4 \cdot H_2O$
Constants:
  Mol. Wt. 118.48
  M. P. 50°C
  B. P. Explodes @110°C
  Density 1.88; liquid: 1.776 @ 50°C
Toxicity: Highly corrosive. See Perchloric Acid and Sulfuric Acid.
Fire Hazard: A very powerful oxidizer. See Perchlorates.
Explosion Hazard: See Perchlorates.
Disaster Control: See Perchlorates.
Storage and Handling: Section 7

PERCHLORIC ACID (NOT OVER 72%)

Description: Clear liquid.
Formula: $HClO_4 \cdot 3H_2O$
Constants:
  Mol. Wt. 154.5
  M. P. −18°C
  B. P. 200°C
  Density 1.5967 @25°/4°C
Shipping Regulations: Section 11.
  I. C. C. Classification: Corrosive liquid; white label.
  Coast Guard Classification: Corrosive liquid; white label.
  MCA warning label.

PERCHLORIC ACID (OVER 72%)

Synonym: Perchloric acid dihydrate.
Description: Stable liquid.
Formula: $HClO_4 \cdot 2H_2O$
Constants:
  Mol. Wt. 136.5
  M. P. −17.8°C
  B. P. 200°C
  Density 1.7129 @25°/4°C
Shipping Regulations: Section 11.
  I. C. C. Classification: See Section 11, §73.269
  Coast Guard Classification: Not permitted.
  MCA warning label.

PERCHLOROETHYLENE

Synonyms: Tetrachloroethylene; ethylene tetrachloride; carbon dichloride.

Description: Colorless liquid; chloroform-like odor.

Formula: CCl_2CCl_2

Constants:

Mol. Wt. 165.85
M. P. -23.35°C
B. P. 121.20°C
Flash P. None
Density 1.6311 @15°/4°C
Vap. Press. 15.8 mm @22°C
Vap. D. 5.83

Toxic Hazard Rating:

Acute Local: Irritant 2
Acute Systemic: Ingestion 3; Inhalation 2; Skin Absorption 2
Chronic Local: Irritant 2
Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2

MAC: ACGIH (accepted); 200 parts per million in air; 1360 milligrams per cubic meter of air.

Toxicology: Not corrosive or dangerously reactive, but toxic by inhalation, by prolonged or repeated contact with the skin or mucous membrane, or when ingested by mouth. The liquid can cause injuries to the eyes; however, with proper precuations it can be handled safely. The symptoms of acute intoxication from this material are the result of its effects upon the nervous system.

Exposures to higher concentrations than 200 ppm cause irritation, lachrymation and burning of the eyes and irritation of the nose and throat. There may be vomiting, nausea, drowsiness, an attitude of irresponsibility, and even an appearance resembling alcoholic intoxication. This material also acts as an anesthetic, through the inhalation of excessive amounts within a short time. The symptoms of fatal intoxication are irritation of the eyes, nose and throat, then fullness in the head; mental confussion; there may be headache, stupefaction, nausea and vomiting. Personnel suffering from subacute poisoning may suffer from such symptoms as headache, fatigue, nausea, vomiting, mental confusion and temporary blurring of the vision. This can occur when inadequate ventilation results in concentrations higher than 200 ppm, or where the vapor concentrations are intermittently high due to faulty handling of the material, or when an individual fails to take adequate precautionary measures.

This material can cause dermatitis, particularly after repeated or prolonged contact with the skin. The dermatitis is preceded by a reddening and burning, and more rarely, a blistering of the skin. In any event, the skin becomes rough and dry, due largely to the removal of skin oils by the material. The skin then cracks easily and is readily susceptible to infection (Section 9). Upon ingestion it causes irritation of the gastrointestinal tract which in turn causes nausea, vomiting, diarrhea and bloody stools. However, such effects are usually less severe than the effects of swallowing similar amounts of other chlorinated hydrocarbons.

It may be handled in the presence or absence of air, water, and light with any of the common construction materials at temperatures up to 140°C. This material is extremely stable and resists hydrolysis.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations: Section 11. MCA warning label.

PERCHLOROMETHYL MERCAPTAN

Synonyms: Thiocarbonyl tetrachloride; trichloromethane sulfonyl chloride.

Description: Yellow oily liquid.

Formula: $ClSCCl_3$

Constants:

Mol. Wt. 185.90
B. P. Slight decomp. @149°C
Density 1.700 @20°C
Vap. D. 6.414

Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: Ingestion 3; Inhalation 3
MAC: ACGIH (tentative); 0.1 part per million in air.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.

PERCHLORYL FLUORIDE

Synonym: PF
Description: Colorless, non-corrosive gas with a characteristic sweet odor.
Formula: ClO_3F
Constants:
  Mol. Wt. 102.5
  M. P. −146 ± 2°C
  B. P. −46.8°C
Toxicity: Moderately toxic. Forms methemoglobin in the body and destroys red cells causing anemia, anorexia and cyanosis. Recovery is said to be rapid, leaving no permanent physiological damage. Can be absorbed through the skin. Its odor can be detected as low as 10 ppm, although this cannot be relied upon as an indication of toxic concentrations in air. The chronic effects are not known.
Fire Hazard: Moderate; while nonflammable, it supports combustion. It is a powerful oxidizer.
Explosion Hazard: Moderate; contact with readily oxidized substances, such as hydrogen sulfide, charcoal, sawdust, lampblack, etc. yield explosive products down to −78°C in some cases.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and fluorides.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Compressed gas N. O. S., green label.

PERCUSSION CAPS AND FUSES.

See Explosives, High.
Shipping Regulations: Section 11.
  I. C. C. Classification (caps and fuzes): Explosive C.
  Coast Guard Classification (caps and fuzes): Explosive C.

PERFORMIC ACID

Synonym: Formyl hydroperoxide.
Description: Liquid.
Formula: HCOOOH
Constant:
  Mol. Wt. 62.0
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: See Peroxides, Organic.
Explosion Hazard: See Peroxides, Organic.
Disaster Control: See Peroxides, Organic.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PERFUMES

Composition: Essential oils and alcohol.
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: Ingestion 2; Inhalation 1
  Chronic Local: Allergen 1
  Chronic Systemic: Inhalation 1
Fire Hazard: Moderate. See Alcohol.
Disaster Control: Moderately dangerous due to flammability of alcohol.
Personal Hygiene: Section 3
Storage and Handling: Section 7

PERILLA OIL

Constants: M. P. −5°C

Flash P. 522°F (C.C.)
Density 0.93 - 0.94
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: Yes
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

PERIODIC ACID

Synonym: Paraperiodic acid.
Description: White, deliquescent crystals.
Formula: $HIO_4 \cdot 2H_2O$
Constants:
Mol. Wt. 228.0
M. P. 110°C
B. P. Decomposes @140°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, by chemical reaction; an oxidizing agent (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of iodides; reacts vigorously with reducing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PERMANGANATE OF POTASH.

See Potassium Permanganate.
Shipping Regulations: Section 11.
I.C.C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

PERMANGANATE OF SODA.

See Sodium Permanganate.
Shipping Regulations: Section 11.
I.C.C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

PERMANGANATES

Composition: Compounds containing a MnO_4^- radical.
Toxicity: See Manganese Compounds.
Fire Hazard: Moderate by chemical reaction with reducing agents.
Explosion Hazard: Moderate, when shocked or exposed to heat. Silver permanganate and other metallic permanganates may detonate when exposed to high temperatures or when they are involved in fires or severely shocked. They should be stored in a cool, ventilated area, away from acute fire hazards and easily oxidized materials. They may be disposed of by dissolving in water. Practically all permanganates are soluble in water.
Disaster Control: Dangerous; shock or heat may explode them; they can react vigorously on contact with reducing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

PERMANGANIC ACID

Description: In solution only.
Formula: $HMnO_4$
Constant:
Mol. Wt. 119.9
Toxicity: Highly toxic. See Manganese Compounds.
Fire Hazard: See Permanganates.
Explosion Hazard: See Permanganates.
Disaster Control: See Permanganates.
Storage and Handling: Section 7

PERMANGANYL CHLORIDE

Toxicity: Highly toxic. See Manganese Compounds.
Explosion Hazard: Moderate, when exposed to heat.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

PERONINE

Synonym: Morphine benzyl ether hydrochloride.
Description: White prismatic, crystalline, odorless powder; bitter taste.
Formula: $C_{17}H_{17}NO(OH)OC_7H_7 \cdot HCl$
Constant:
  Mol. Wt. 411.9
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

PEROXIDES, INORGANIC

Toxicity: Variable. They may cause injury on contact with skin or mucous membranes. See also Hydrogen Peroxide.
Fire Hazard: Moderate to dangerous by chemical reaction with reducing agents and contaminants; strong oxidizing agents; contact with moisture may produce much heat. See also Hydrogen Peroxide and Sodium Peroxide (Section 6).
Explosion Hazard: Moderate; heat shock or catalysts can cause violent decomposition. Contact with reducing agents may give rise to explosively violent reactions.
Disaster Control: Dangerous; shock heat or moisture may cause explosion; reacts with reducing agents.
Storage and Handling: Section 7

PEROXIDES, ORGANIC, LIQUID, N.O.S.

Caution: These materials are irritating to the skin, eyes and mucous membranes.
Fire Hazard: Dangerous, by chemical reaction with reducing agents or exposure to heat. They are powerful oxidizers.
Explosion Hazard: Severe, when shocked, exposed to heat or by spontaneous chemical reaction. Many peroxides are very unstable. Upon contact with reducing materials an explosive reaction can occur.
Disaster Control: Dangerous; shock or heat may explode them; reacts with reducing materials.
Storage and Handling: They should be stored in a cool, ventilated, isolated area away from organic or other easily oxidizable materials and away from acute fire hazards. Containers should be kept closed and plainly labelled. Personnel should be cautioned regarding their use. Personnel who must be exposed to these materials should use protective equipment. Recommended are protective clothing to avoid skin contact, chemical safety goggles for protection of the eyes, and a respirator to avoid the inhalation of extensive amounts of these materials in vapor form (Section 7).
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable liquid, red label; oxidizing material, yellow label.
  Coast Guard Classification: Inflammable liquid, red label; oxidizing material, yellow label.

PEROXY DISULFURIC ACID

Synonym: Persulfuric acid.
Description: Hygroscopic crystals.
Formula: $H_2S_2O_8$
Constants:
  Mol. Wt. 194.15
  M. P. Decomposes @65°C
  B. P. Decomposes
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: Irritant 2
  Chronic Systemic: U
Fire Hazard: Moderate, by chemical reaction; a powerful oxidizer (Section 6).
Disaster Control: Dangerous; on decomposition, it emits highly toxic fumes of oxides of sulfur.

Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PEROXY SULFURIC ACID

Description: White crystals.
Formula: H_2SO_5
Constants:
  Mol. Wt. 114.08
  M. P. Decomposes @45°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate by chemical reaction; a powerful oxidizer. (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

"PETROHOL" 91%

Synonym: Isopropyl alcohol.
Description: Clear liquid.
Constants:
  Flash P. 66°F
  Autoign. Temp. 895°F
Toxicity: Moderate. See Isopropyl alcohol.
Fire Hazard: Dangerous, when exposed to heat or flame.
Disaster Control: Dangerous; keep away from heat and open flame; can react on contact with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

"PETROHOL" 98%

Synonym: Isopropyl alcohol.
Description: Clear liquid.
Constants:
  Flash P. 59°F
  Autoign. Temp. 845°F
Toxicity: Moderate. See Isopropyl Alcohol.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

PETROLEUM ETHER. See Petroleum Spirits.

Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable liquid, red label; combustible liquid.
  Coast Guard Classification: Combustible liquid; inflammable liquid, red label.

PETROLEUM NAPHTHAS AND SOLVENTS

Shipping Regulations: Section 11.
  Coast Guard Classification: Combustible liquid; inflammable liquid, red label.
  MCA warning label

PETROLEUM SPIRITS

Synonyms: Petroleum benzine; petroleum naphtha; light ligroin; petroleum ether.
Description: Volatile, clear, colorless and non-fluorescent liquid.
Constants:
  M. P. < -73°C
  B. P. 40 - 80°C
  Flash P. -50°F (C.C.)
  Density 0.635 to 0.660
  Autoign. Temp. 475°F
  Vap. D. 2.50
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 2; Inhalation 1
  Acute Systemic: Inhalation 1
  Chronic Local: Irritant 1
  Chronic Systemic: U
Fire Hazard: Highly dangerous; when exposed to heat, flame, sparks, etc.
Spontaneous Heating: No
Underwriters Laboratory Classification: 95 - 100
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame.

Explosive Range: 1.4 - 5.9%
Disaster Control: Highly dangerous; keep away from heat or flame!
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

PETROLEUM SULFONATE

Constant:
  Flash P. 400°F (O.C.)
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

PHENACAINE HYDROCHLORIDE

Description: Small, white crystals.
Formula:
  $(C_2H_5OC_6H_4)_2N_2HCCH_3 \cdot HCl \cdot H_2O$
Constants:
  Mol. Wt. 352.8
  M. P. 190°C
Toxic Hazard Rating:
  Acute Local: Anesthetic
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

PHENANTHRENE

Description: Solid or monoclinic crystals.
Formula: $(C_6H_4CH)_2$
Constants:
  Mol. Wt. 178.22
  M. P. 97°C
  B. P. 339°C
  Density 1.179 @25°C
  Vap. Press. 1 mm @118.3
  Vap. D. 6.14
Toxicity: Details unknown. Possibly a carcinogen.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide or dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

PHENARSAZINE CHLORIDE

Synonyms: Adamsite; diphenylamine chlorarsine.
Description: Pure: light yellow crystals; technical: dark green or brown crystals.
Formula: $HN(C_6H_4)_2AsCl$
Constants: Mol. Wt. 277.57
  M. P. 182 - 195°C
  B. P. 410°C Decomposes
  Density 1.648 @20°C
  Vap. Press. 2×10^{-13} mm @20°C
  Volatility 0.02 mg/m^3
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

PHENAZINE

Synonym: Dibenzopyrazine.
Description: Pale yellow crystals.
Formula: $C_{12}H_8N_2$
Constants:
  Mol. Wt. 180.2
  M. P. 171°C
  B. P. Above 360°C (sublimes)
Toxicity: Details unknown; a larvicide.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

PHENAZINE OXIDE

Toxicity: Details unknown; an insecticide.
Fire Hazard: Slight; when heated, it emits toxic fumes (Section 6).
Storage and Handling: Section 7

PHENETHYL ALCOHOL

Synonyms: 2-Phenyl ethanol; benzyl carbinol.
Description: Colorless liquid; floral odor of roses.
Formula: $C_6H_5CH_2CH_2OH$
Constants:
  Mol. Wt. 122.14
  M. P. -27°C
  B. P. 220°C
  Flash P. 216°F
  Density 1.0245 @15°C
  Vap. D. 4.21

Toxicity: Details unknown. See also Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

o-PHENETIDINE
Synonym: 2-Aminophenetole.
Description: Oily liquid.
Formula: $C_8H_{11}NO$
Constants:
  Mol. Wt. 137.2
  M. P. Below -20°C
  B. P. 229°C
  Vap. Press. 1 mm @67.0°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: Ingestion 2; Inhalation 2
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of nitrogen oxides.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
MCA warning label

p-PHENETIDINE
Synonym: 4-Aminophenetole.
Description: Colorless liquid.
Formula: $C_8H_{11}NO$
Constants:
  Mol. Wt. 137.2
  M. P. 3°C
  B. P. 254°C
  Flash P. 240°F
  Density 1.0652 @16°/4°C
  Vap. D. 4.73
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: Ingestion 2; Inhalation 2
Fire Hazard: Slight, when exposed to heat or flame.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of nitrogen oxides; reacts vigorously with powerful oxidizers.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
MCA warning label

PHENOBARBITAL
Description: White, shining, crystalline, odorless powder; bitter taste.
Formula: $CO(NHCO)_2C(C_2H_5)(C_6H_5)$
Constants:
  Mol. Wt. 232.2
  M. P. 174 - 178°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2
  Chronic Local: U
  Chronic Systemic: Ingestion 1
Caution: Repeated ingestion may lead to habituation.
Fire Hazard: Slight; when heated to decomposition, it emits toxic fumes (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

PHENOL
Synonyms: Carbolic acid; phenic acid; phenylic acid.
Description: White, crystalline mass which turns pink or red if not perfectly pure; burning taste, distinctive odor.
Formula: C_6H_5OH
Constants:
  Mol. Wt. 94.11
  M. P. 40.6°C
  B. P. 181.9°C
  Flash P. 175°F (C. C.)
  Density 1.072
  Auotign. Temp. 1319°F
  Vap. Press. 1 mm @40.1°C
  Vap. D. 3.24
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
  Chronic Local: Irritant 2
  Chronic Systemic: Ingestion 2; Inhalation; Skin Absorption 2
MAC: ACGIH (accepted); 5 parts

per million in air; 19 milligrams per cubic meter of air.

Toxicology: In acute phenol poisoning, the main effect is on the central nervous system. Absorption from spilling phenolic solutions on the skin may be very rapid, and death results from collapse within 30 minutes to several hours. Death has resulted from absorption of phenol through a skin area of 64 square inches. Where death is delayed, damage to the kidneys, liver, pancreas, spleen, and edema of the lungs may result. Absorbed phenol is partly excreted by the kidneys, partly oxidized. Part of the excreted portion is combined with sulfuric and glycuronic acids, the remainder is excreted unchanged. The symptoms develop rapidly, frequently within 15 to 20 minutes following spilling of phenol on the skin. Headache, dizziness, muscular weakness, dimness of vision, ringing in the ears, irregular and rapid breathing, weak pulse, and dyspnea may all develop, and may be followed by loss of consciousness, collapse and death. When taken internally, there is also nausea, with or without vomiting, severe abdominal pain, and corrosion of the lips, mouth, throat, esophagus and stomach. There may be perforation. On the skin, the affected area is white, wrinkled and softened, and there is usually no immediate complaint of pain; later, intense burning is felt, followed by local anesthesia and still later, by gangrene.

Chronic poisoning, following prolonged exposures to low concentrations of the vapor or mist, results in digestive disturbances (vomiting, difficulty in swallowing, excessive salivation, diarrhea, loss of appetite), nervous disorders (headache, fainting, dizziness, mental disturbances) and skin eruptions. Chronic poisoning may terminate fatally in cases where there has been extensive damage to the kidneys or liver. Dermatitis resulting from contact with phenol or phenol-containing products is fairly common in industry.

Fire Hazard: Moderate, when exposed to heat or flame.

Spontaneous Heating: No

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Disaster Control: Dangerous; when heated it emits toxic fumes; can react with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

Shipping Regulations: Section 11.

  I. C. C. Classification: Poison B; poison label.

  Coast Guard Classification: Poison B; poison label (liquid and solid).

  MCA warning label.

PHENOLPHTHALEIN

Synonym: 3, 3-bis(p-hydroxyphenyl)-phthalide.

Description: Small crystals.

Formula: $C_{20}H_{14}O_4$

Constants:

  Mol. Wt. 318.3

  M. P. 260°C

  Density 1.277

Toxic Hazard Rating:

  Acute Local: U

  Acute Systemic: Ingestion 3

  Chronic Local: U

  Chronic Systemic: U

Disaster Control: Dangerous; when heated, it emits acrid fumes.

Personal Hygiene: Section 3

Storage and Handling: Section 7

PHENOLS, HIGH-BOILING

Description: Liquid.

Composition: Allkyl substituted phenols.

Constants:

  Mol. Wt. 150 (ave.)

  B. P. 238 - 288°C

  Freezing P. < −40°C

  Flash P. 250°F (O.C.)

  Density 1.033 @20°/20°C

  Vap. Press. 0.01 mm @20°C

  Vap. D. Approx. 5.2

Toxicity: See Phenol.

Fire Hazard: Slight, when exposed to heat or flame; can react with

oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated it emits toxic fumes.
Storage and Handling: Section 7

PHENOL SULFONATE

Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: Irritant 1
  Chronic Systemic: Ingestion 2; Inhalation 2
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PHENOLSULFONIC ACID

Synonym: Sulfocarbolic acid.
Description: Yellowish liquid; a mixture of o- and p- phenolsulfonic acid.
Formula: $C_6H_5SO_3H$
Constants: Mol. Wt. 174.17
  M. P. 50°C Density 1.155
Toxicity: Details unknown; less irritating and less toxic than phenol. See Phenol and Sulfuric Acid.
Disaster Control: Dangerous; when heated, it emits highly toxic fumes of sulfur compounds; will react with water or steam to produce heat.
Storage and Handling: Section 7

PHENOTHIAZINE

Synonym: Thiodiphenylamine.
Description: Grayish-green powder.
Formula: $C_{12}H_9NS$
Constants: Mol. Wt. 199.2
  M. P. 175 - 179°C
  B. P. 371°C (decomp.)
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2
  Acute Systemic: Ingestion 2
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur and nitrogen.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
MCA warning label

PHENOTHIOXIN

Synonym: Dibenzothioxin.
Description: A powder.
Formula: $C_{12}H_8OS$
Constant:
  Mol. Wt. 200.2
Toxicity: Details unknown; louse powder.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of sulfur compounds.
Storage and Handling: Section 7

PHENYLACETIC ACID

Synonyms: α-Toluic acid.
Description: White crystals; sweet, floral honey-like odor.
Formula: $C_6H_5CH_2COOH$
Constants:
  Mol. Wt. 136.14
  M. P. 76.7°C
  B. P. 265.5°C
  Density 1.228 @20°/4°C
  Vap. Press. 1 mm @97.0°C
Toxicity: Details unknown; a fungicide; probably highly toxic. See also Toluene.
Disaster Control: Dangerous; when heated, it emits toxic fumes.
Storage and Handling: Section 7

PHENYLACETONITRILE

Synonym: Benzyl cyanide.
Description: Oily liquid; aromatic odor.
Formula: $C_6H_5CH_2CN$
Constants:
  Mol. Wt. 118.2
  M. P. -23.8°C
  B. P. 233.5°C
  Density 1.0214 @15°/15°C
  Vap. Press. 1 mm @60.0°C
Toxicity: Highly toxic. See Cyanides.
Disaster Control: Dangerous. See Cyanides.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHENYL ARSONIC ACID
Description: Crystalline powder.
Formula: $C_6H_5AsO(OH)_2$
Constants:
Mol. Wt. 202
M. P. 160°C Decomposes
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: Dangerous. See Arsenic Compounds.
Storage and Handling: Section 7

PHENYL AZOIMIDE
Synonyms: Diazobenzeneimide; triazobenzene.
Description: Yellow oil.
Formula: $C_6H_5N_3$
Constants:
Mol. Wt. 119.1
B. P. 59°C (explodes)
Density 1.078 @22.5°C
Toxicity: Details unknown. See also Benzene.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: Severe, when shocked, exposed to heat or flame or by chemical reaction.
Explosive Range: @59°C.
Disaster Control: Dangerous; shock or heat will explode it; can react with oxidizing materials; on contact with acid or acid fumes it can emit toxic fumes.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

PHENYL BENZOATE
Description: Colorless crystals, geranium odor.
Formula: $C_6H_5COOC_6H_5$
Constants:
Mol. Wt. 198.2
M. P. 70°C
B. P. 314°C
Density 1.235
Vap. Press. 1 mm @106.8°C
Toxicity: See Phenol and Benzoic Acid.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

1-PHENYLBENZOTHIAZOLE
Toxicity: Details unknown; a larvicide.

PHENYLBIGUANIDE
Synonym: Phenylbiguanide.
Description: Colorless crystals.
Toxicity: Details unknown.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of nitrogen compounds.
Storage and Handling: Section 7

PHENYLBIGUANIDE HYDROCHLORIDE. See Phenylbiguanide.

PHENYLBIGUANIDE MERCAPTO BENZOTHIAZOLE SALT. See Phenylbiguanide.

1-PHENYLBUTENE-2
Description: A liquid.
Formula: $C_{10}H_{12}$
Constants:
Mol. Wt. 132.2
B. P. 175°C
Flash P. 160°F (T.O.C.)
Density 0.888 @15.5°/15.5°C
Toxicity: Unknown
Fire Hazard: Moderate, in the presence of heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

PHENYL "CARBITOL"
Synonym: Diethylene glycol monophenyl ether.
Description: Liquid.
Formula: $C_6H_5OC_2H_4OC_2H_4OH$
Constants:
Mol. Wt. 182.21
B. P. 207°C @55 mm
Freezing P. -50°C
Density 1.1158 @20°/20°C
Vap. Press. < 0.01 mm @20°C
Vap. D. 6.28
Toxicity: Details unknown. See also Glycols.
Disaster Control: Slightly dangerous; when heated, it emits acrid fumes.
Storage and Handling: Section 7

PHENYL CARBYLAMINE CHLORIDE
Synonym: Phenyliminophosgene.

Description: Pale yellow, oily liquid.
Formula: $C_6H_5NCCl_2$
Constants:
  Mol. Wt. 174.03
  B. P. 208 to 210°C
  Density 1.30 @15°C
  Vap. D. 6.03
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides. A tear gas.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Poison A; poison gas label.
  Coast Guard Classification: Poison A; poison gas label.

PHENYL "CELLOSOLVE"

Synonym: Ethylene glycol monophenyl ether.
Description: Clear liquid.
Formula: $C_6H_5O(CH_2)_2OH$
Constants: Mol. Wt. 138.2
  M. P. 14°C
  B. P. 242°C
  Flash P. 250°F (O. C.)
  Density 1.109
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated, it emits acrid fumes.
Storage and Handling: Section 7

2-PHENYL-6-CHLOROPHENOL

Synonym: 6-Chlor-orthoxenol.
Description: Pale yellow, viscous liquid.
Formula: $C_{12}H_9ClO$
Constants:
  Mol. Wt. 204.7
  M. P. 6°C
  B. P. 318°C (decomp.)
  Density 1.24 @25°/4°C
Toxicity: Details unknown; a germicide and fungicide. See also Chlorophenol.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

PHENYLCHLOROPHENYL TRICHLOROETHANE

Description: Crystals.
Formula: $C_6H_5ClC_6H_4Cl_3C_2H$
Constant:
  Mol. Wt. 320.1
Toxicity: Details unknown; an insecticide. See also DDT which is a related compound.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

PHENYLCYCLOHEXANE

Synonym: Cyclohexylbenzene.
Description: Colorless, oily liquid.
Formula: $C_{12}H_{16}$
Constants:
  Mol. Wt. 160.25
  M. P. 7.5°C
  B. P. 240.0°C
  Flash P. 210°F (O. C.)
  Density 0.938 ±0.02 @25°/15.6°C
  Autoign. Temp. 220°F
  Vap. Press. 1 mm @67.5°C
Toxicity: Details unknown. See also Cyclohexane.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Storage and Handling: Section 7

2-PHENYL CYCLOHEXANOL

Description: Colorless to pale, straw-colored liquid.
Formula: $C_6H_{10}C_6H_5OH$
Constants:
  Mol. Wt. 176.2
  B. P. 276 - 281°C
  Flash P. 280°C
  Density 1.033 @25°/25°C
  Vap. D. 6.13
Toxicity: See Alcohols.
Fire Hazard: Slight; when exposed

to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

PHENYL CYCLOHEXYL HYDROPEROXIDE

Description: Available as solution.
Formula: $C_{12}H_{16}O_2$
Constant:
Mol. Wt. 192
Flash P. > 212°F
Toxicity: Details unknown. See also Peroxides, Organic.
Fire Hazard: Slight, when exposed to heat or flame or by spontaneous chemical reaction.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated, it burns and emits acrid fumes; can react with oxidizing or reducing materials.
Storage and Handling: Section 7

PHENYL DIAZO SULFIDE

Description: Red crystals.
Formula: $(C_6H_5N_2)_2S$
Constant:
Mol. Wt. 242.3
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat (Section 6).
Explosion Hazard: Severe, when shocked or exposed to heat; when dry it can explode at room temperature.
Disaster Control: Dangerous; shock will explode it; on decomposition it emits highly toxic fumes of oxides of sulfur and nitrogen; can react with oxidizing materials.
Storage and Handling: Section 7

PHENYL DICHLOROARSINE, LIQUID

Description: Colorless gas or liquid; changes to yellow.
Formula: $C_6H_5AsCl_2$
Constants:
Mol. Wt. 222.92
B. P. 255 - 257°C
Freezing P. −15.6°C
Density 1.654 @20°C
Vap. Press. 0.021 mm @20°C
Vap. D. 7.7
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: Dangerous; shock can shatter the compressed gas container, releasing contents; when heated to decomposition, it emits highly toxic fumes of arsenic; will react with water or steam to produce corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

PHENYL DIETHANOL AMINE

Description: Liquid.
Formula: $C_6H_5N(CH_2CH_2OH)_2$
Constants: Mol. Wt. 181.23
M. P. 57.8°C
B. P. 192°C
Flash P. 375°F (O. C.)
Density 1.1203
Vap. Press. <0.01 mm @20°C
Toxicity: See Amines.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

m-PHENYLENEDIAMINE

Synonym: m-Diaminobenzene.
Description: White crystals.
Formula: $C_6H_4(NH_2)_2$
Constants:
Mol. Wt. 108.1
M. P. 63°C
B. P. 286°C
Density 1.139
Vap. Press. 1 mm @99.8°C
Toxicity: Somewhat less than p-Phenylene Diamine.
Fire Hazard: Slight; when heated to decomposition, it emits toxic fumes (Section 6).
Storage and Handling: Section 7
MCA warning label

o-PHENYLENEDIAMINE

Synonym: o-Diaminobenzene.
Description: Brownish crystals.

Formula: $C_6H_4(NH_2)_2$
Constants:
  Mol. Wt. 108.1
  M. P. 104°C
  B. P. 257°C
Toxicity: Somewhat less than p-Phenylene Diamine.
Fire Hazard: Slight; when heated to decomposition, it emits toxic fumes (Section 6).
Storage and Handling: Section 7

p-PHENYLENE DIAMINE

Synonym: Diaminobenzene; ursol.
Description: Colorless crystals.
Formula: $C_6H_4(NH_2)_2$
Constants:
  Mol. Wt. 108.1
  M. P. 139.7°C
  B. P. 267°C
  Flash P. 312°F
  Vap. D. 3.72
Toxic Hazard Rating:
  Acute Local: Irritant 2; Allergen 1
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: Allergen 2
  Chronic Systemic: Ingestion 2; Inhalation 2
Toxicology: Of the three phenylene diamines, the para form has proved to be an especially powerful skin irritant. This material is also responsible for asthmatic symptoms and other respiratory symptoms of workers in the fur dye industry where it is commonly used. The p- form will cause kerato-conjunctivitis, swollen conjunctiva, and eczema of the eyelids. Systemic poisoning from this material is uncommon. At least one fatal case of liver involvement due to the para form has been reported in the literature. m- and o-Phenylene diamine are somewhat less toxic than the p- isomer. For this reason and possibly because they are much less used in industry, they are not considered to be industrial hazards. All forms are flammable liquids and moderate fire hazards.
Treatment and Antidotes: If removal from exposure is prompt, the symptoms will be relieved. If the exposure has been severe, a physician should be called at once. If the material has come in contact with the eyes, mucous membranes, or the skin, the contaminated area or the involved skin areas should be washed promptly with plenty of lukewarm water and soap.
Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated, it burns and emits highly toxic fumes of nitrogen compounds; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
MCA warning label

PHENYLETHANOLAMINE

Description: Liquid.
Formula: $C_6H_5NHCH_2CH_2OH$
Constants: Mol. Wt. 137.18
  B. P. 285.2°C
  Flash P. 305°F (O. C.)
  Density 1.097 @20°/20°C
  Vap. Press. < 0.01 mm @20°C
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PHENYL ETHYL ACETATE

Description: Colorless liquid.
Formula: $C_6H_5C_2H_4OOCCH_3$
Constants:
  Mol. Wt. 164.2
  B. P. 223.6°
  Freezing P. <-20°C

Flash P. 230°F
Density 1.032 @25°/25°C
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated, it emits acrid fumes; can react with oxidizing materials.
Storage and Handling: Section 7

β-PHENYLETHYLAMINE
Description: Colorless to slightly yellow liquid.
Formula: $C_6H_5(CH_2)_2NH_2$
Constants:
Mol. Wt. 121.2
B. P. 200°C
Density 0.96 @15.5°/15.5°C
Vap. D. 4.18
Toxicity: Details unknown. See also Amines.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

PHENYLETHYL BENZOATE
Description: Crystals.
Formula: $C_2H_5C_6H_4C_6H_4COOH$
Constant:
Mol. Wt. 226.3
Toxicity: An insecticide. See Benzoic Acid.
Fire Hazard: Slight, when exposed to flame (Section 6).
Disaster Control: Slightly dangerous; when heated to decomposition it emits acrid fumes; can react with oxidizing materials.
Storage and Handling: Section 7

PHENYL ETHYLENE
Synonym: Vinylbenzene.
Description: Colorless liquid.
Formula: $C_6H_5CHCH_2$
Constants:
Mol. Wt. 104.14
M. P. -31°C
B. P. 146°C
Flash P. 88°F
Density 0.9074 @20°/4°C
Autoign. Temp. 914°F
Vap. D. 3.6
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
Toxicology: It can cause irritation, violent itching of the eyes, lachrymation, and severe human eye injuries. Its toxic effects are usually transient and result in irritation and possible narcosis. It is not considered a very toxic material, because under ordinary conditions it does not vaporize sufficiently to reach a concentration that can kill animals, such as rats and guinea pigs, in a few minutes. Experimentally it has been found that 10,000 ppm was dangerous to animal life in from 30 to 60 minutes, 2,500 ppm was dangerous to life in 8 hours, while 1,300 ppm was the highest amount which was found to cause no serious systemic disturbances in 8 hours. However, all animals exposed to these amounts did evidence eye and nasal irritation, while those exposed to 2,500 ppm or more showed varying degrees of weakness and stupor, followed by incoordination, tremors and unconsciousness. To produce this unconsciousness required 10 hours at a concentration of 2,500 ppm. From a study to determine the chronic effects of this material, it was discovered that rats exposed to 1,300 ppm for from 7 to 8 hours per day 5 days a week for 26 weeks showed evidence and definite signs of eye and nasal irritation and appeared unkempt, though they made a normal gain in weight and presented no significant microscopic tissue changes or changes in the blood picture. 12 rabbits exposed to 1,300 ppm for the same period of time with one unexplained exception showed similar results.
Treatment and Antidotes: Personnel who show symptoms of irritation or beginning narcosis due to exposure to this material should be

removed from exposure and the symptoms will disappear. If the symptoms persist, consult a physician.
Fire Hazard: Moderate, when exposed to flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 1.1 - 6.1%.
Disaster Control: Dangerous, upon exposure to heat or flame; on decomposition it emits acrid fumes; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PHENYL ETHYL ETHANOLAMINE

Description: Crystals.
Formula: $C_6H_5N(C_2H_5)C_2H_4OH$
Constants:
Mol. Wt. 165.23
M. P. 37.2°C
B. P. 268°C @740mm
Flash P. 270°F (O.C.)
Density 1.04 @20°/20°C
Vap. Press. < 0.01 mm @20°C
Toxicity: Details unknown. See also Amines.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

PHENYLHYDRAZINE

Description: Yellow, monoclinic crystals or oil.
Formula: $C_6H_5NHNH_2$
Constants:
Mol. Wt. 108.14
M. P. 19.6°C
B. P. 243.5°C Decomposes
Flash P. 192°F (C.C.)
Density 1.0978 @20°/4°C
Vap. Press. 1 mm @71.8°C
Vap. D. 3.7
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 1
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Irritant 2; Allergen 2
Chronic Systemic: Ingestion 2; Inhalation 2
MAC: ACGIH (tentative); 5 parts per million in air.
Toxicology: The ingestion or subcutaneous injection of phenyl hydrazine has been shown to cause hemolysis of the red blood cells, an effect which has been utilized in the treatment of polycythemia. The erythrocytes frequently contain Heinz bodies. Part of the hemoglobin is converted to methemoglobin. Pathological changes seen in animals include congestion of the spleen with hyperplasia of the reticuloendothelial system, degeneration and necrosis of the liver cells with extensive pigmentation, early damage to the tubules of the kidneys with fatty changes in the cortical portion, and hyperplasia of the bone marrow. The most common effect of occupational exposure is the development of dermatitis which, in sensitized persons, may be quite severe. Systemic effects include anemia and general weakness, gastro-intestinal disturbances and injury to the kidneys.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of nitrogen compounds; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PHENYLHYDRAZINE HYDROCHLORIDE

Description: Leaflets.
Formula: $C_6H_5NHNH_2 \cdot HCl$
Constants:
Mol. Wt. 144.6
M. P. 245°C
Toxicity: See Phenylhydrazine.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of nitrogen compounds

and chlorides.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

PHENYL ISOCYANATE
Description: Liquid.
Formula: C_6H_5NCO
Constants:
  Mol. Wt. 119.1
  M. P. −30°C approx.
  B. P. 166°C
  Density 1.1 @20°C
  Vap. Press. 1 mm @10.6°C
Toxicity: Highly toxic. See Isocyanates.
Disaster Control: See Isocyanates.
Storage and Handling: Section 7

PHENYL MAGNESIUM BROMIDE
Description: A solid.
Formula: C_6H_5MgBr
Constant:
  Mol. Wt. 181.3
Toxicity: Probably high. See also Bromides and Phenol.
Fire Hazard: Dangerous, by chemical reaction.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, by chemical reaction.
Disaster Control: Dangerous; will react with water, steam or acids to produce heat and toxic and flammable vapors; can react vigorously with oxidizing materials; on decomposition it emits toxic fumes of bromides.
Storage and Handling: Section 7

N-PHENYLMALEAMIC ACID
Synonym: Maleanilic acid.
Description: Yellow, crystalline solid.
Formula: $C_{10}H_9O_3N$
Constants:
  Mol. Wt. 191.18
  M. P. 190°C
  Density 1.418 @30°C
Toxic Hazard Rating (animal studies):
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Slight; when heated to decomposition it emits toxic fumes (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PHENYL MERCAPTAN
Synonym: Thiophenol.
Description: Liquid; repulsive odor.
Formula: C_6H_5SH
Constants:
  Mol. Wt. 110.2
  B. P. 168.3°C
  Density 1.0728 @25°/4°C
Toxicity: Details unknown; mosquito larvicide. See also Mercaptans.
Fire Hazard: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition or on contact with acids, it emits toxic fumes of sulfur compounds.
Storage and Handling: Section 7

PHENYL MERCAPTOACETIC ACID
Description: White powder.
Formula: $C_6H_5SCH_2COOH$
Constants:
  Mol. Wt. 168.2
  M. P. 63°C
Toxicity: Details unknown; a fungicide and bactericide; probably highly toxic. See also Mercaptans.
Disaster Control: Dangerous; when heated to decomposition or on contact with acids, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

PHENYL MERCURIC COMPOUNDS
All are highly toxic. For details see Mercury Compounds, Organic.

PHENYLMETHYL CARBINOL
Synonyms: Methylphenylcarbinol; 1-phenylethanol, styralyl alcohol.
Description: Colorless liquid.
Formula: $C_6H_5CH(CH_3)OH$
Constants:
  Mol. Wt. 122.16
  B. P. 204°C
  Freezing P. 21.4°C
  Density 1.015 @20°/20°C

Vap. Press. 0.1 mm @20°C
Vap. D. 4.21
Toxicity: Slight. See Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PHENYL METHYL ETHANOLAMINE

Description: Liquid.
Formula: $C_6H_5N(CH_3)C_2H_4OH$
Constants:
Mol. Wt. 151.2
B. P. 192°C @100 mm
M. P. −30°C
Flash P. 280°F (O.C.)
Density 1.0661 @20°/20°C
Vap. Press < 0.01 mm @20°C
Vap. D. 5.21
Toxicity: See Amines.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; on heating to decomposition it emits highly toxic fumes of nitrogen compounds.
Storage and Handling: Section 7

PHENYL METHYL KETONE

Synonyms: Acetophenone; methylphenyl ketone; hypnone; acetylbenzene.
Description: Colorless liquid or plates.
Formula: $CH_3COC_6H_5$
Constants:
Mol. Wt. 120.14
M. P. 19.7°C
B. P. 202.3°C
Flash P. 221°F
Density 1.026 @20°/4°C
Vap. D. 4.14
Toxicity: Slight. See Ketones.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

4-PHENYLMORPHOLINE

Synonym: N-Phenylmorpholine.
Description: Crystal.
Formula: $C_6H_5\underbrace{NC_2H_4OCH_2C}H_2$
Constants:
Mol. Wt. 163.2
M. P. 57°C
B. P. 270°C
Flash P. 220°F (O.C.)
Density 1.0599 @57°/20°C
Vap. Press. < 0.1 mm @20°C
Vap. D. 5.63
Toxicity: Details unknown; an insecticide.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; on decomposition it emits toxic fumes of nitrogen compounds.
Storage and Handling: Section 7

PHENYL MUSTARD OIL

Synonyms: Thiocarbanil; phenylisothiocyanate; phenylthiocarbonimide.
Description: Pale yellow liquid.
Formula: C_6H_5NCS
Constants:
Mol. Wt. 135.18
M. P. −21°C
B. P. 221°C
Density 1.1382
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides and oxides of sulfur.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PHENYL β-NAPHTHYLAMINE

Synonyms: N-Phenyl-2-naphthylamine.

Description: Needle-like crystals.
Formula: $C_{10}H_7NHC_6H_5$
Constants: Mol. Wt. 219.3
M. P. 108°C
B. P. 399.5°C
Density 1.20
Toxicity: See Naphthylamine.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of nitrogen compounds; can react with oxidizing materials.
Storage and Handling: Section 7

o-PHENYLPHENOL

Synonyms: Orthoxenol.
Description: White, flaky crystals, mild odor.
Formula: $C_6H_5C_6H_4OH$
Constants:
Mol. Wt. 170.2
B. P. 286°C
Freezing P. 57.2°C
Flash P. 255°F
Density 1.217 @25°/25°C
Vap. Press. 1 mm @100.0°C
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: Ingestion 1; Inhalation 1
Chronic Local: U
Chronic Systemic: Ingestion 1
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Personal Hygiene: Section 3
Storage and Handling: Section 7

p-PHENYLPHENOL

Description: Flaky material.
Formula: $C_{12}H_9OH$
Constants:
Mol. Wt. 170.2
M. P. 164.5°C
B. P. 308°C
Flash P. 330°F
Vap. Press. 10 mm @176.2°C
Toxicity: See o-Phenylphenol.
Fire Hazard: Slight; when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

PHENYL PHOSPHINE

Synonym: Phosphaniline.
Description: Liquid.
Formula: $C_6H_5PH_2$
Constants:
Mol. Wt. 110.1
B. P. 160°C
Density 1.001 @15°C
Vap. D. 3.79
Toxicity: Details unknown; probably highly toxic. See also Phosphine.
Fire Hazard: Moderate, when exposed to heat or flame.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosphorus compounds; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

PHENYL SALICYLATE

Synonym: Salol.
Description: Small, white crystals; aromatic odor.
Formula: $C_{13}H_{10}O_3$
Constants:
Mol. Wt. 214.2
M. P. 42°C
B. P. 173°C @12 mm
Density 1.25
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: Ingestion 1
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits toxic fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

PHENYL SILICATE

Description: Solid.
Formula: $Si(OC_6H_5)_4$
Constants:
Mol. Wt. 401.5
M. P. 48°C
Toxicity: Details unknown. See also Phenol.
Fire Hazard: Slight; when heated, it emits toxic fumes (Section 6).
Storage and Handling: Section 7

PHENYLTHIOUREA

Synonym: Phenylthiocarbamide.
Description: Needle-like crystals; bitter taste.
Formula: $C_6H_5NHCSNH_2$
Constants:
Mol. Wt. 152.2
M. P. 154°C
Density 1.3

Toxicity: Details unknown; a rodenticide. The thioureas in general are moderately toxic.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur and nitrogen.
Storage and Handling: Section 7

PHENYLTRICHLOROSILANE
Description: Liquid.
Formula: $C_6H_5SiCl_3$
Constants:
  Mol. Wt. 211.6
  B. P. 201°C
  Flash P. 195°F
  Density 1.321 @25°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Corrosive liquid; white label.
  Coast Guard Classification: Corrosive liquid; white label.

PHENYLURETHANE
Synonym: Phenyl ethyl carbamate.
Description: Crystals.
Formula: $C_6H_5NHCOOC_2H_5$
Constants:
  Mol. Wt. 165.2
  M. P. 53°C
  B. P. 238°C (Slight decomp.)
  Density 1.106
Toxicity: Details unknown; a citrus fruit fungicide.
Disaster Control: Dangerous; when heated, it emits highly toxic fumes of nitrogen compounds.
Storage and Handling: Section 7

PHLORIDZIN
Synonym: Phlorizin.
Description: Silky needles.
Formula: $C_{21}H_{24}O_{10} \cdot 2H_2O$
Constants:
  Mol. Wt. 472.44
  M. P. 170°C Decomposes
  Density 1.4298 @19°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3
  Chronic Local: U
  Chronic Systemic: Ingestion 3
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

PHORONE
Synonym: 2,6-Dimethyl-2-5-heptadien-4-one.
Description: Solid or liquid.
Formula: $(CH_3)_2CCHCOCHC(CH_3)_2$
Constants:
  Mol. Wt. 138.20
  M. P. 28°C
  B. P. 197.2°C
  Flash P. 185°F (O.C.)
  Density 0.879
  Vap. Press. 1 mm @42.0°C
  Vap. D. 0.879
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

PHOSGENE
Synonyms: Carbon oxychloride; carbonyl chloride; CG.
Description: Colorless, gas or colorless, volatile liquid; odor of new mown hay or green corn.
Formula: $COCl_2$
Constants:
  Mol. Wt. 98.92
  M. P. -104°C
  B. P. 8.3°C
  Density 1.37 @20°C
  Vap. Press. 1180 mm @20°C
  Vap. D. 3.4
Toxic Hazard Rating:
  Acute Local: Irritant 3; Inhalation 3
  Acute Systemic: Inhalation 3

Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (accepted); 1 part per million in air; 4 milligrams per cubic meter of air.
Toxicology: In the presence of moisture, phosgene decomposes to form hydrochloric acid and carbon monoxide. This action takes place within the body, when the gas reaches the bronchioles and the alveoli of the lungs. There is little irritant effect upon the respiratory tract, and the warning properties of the gas are therefore very slight. The liberation of hydrochloric acid in the lung tissues results in the development of pulmonary edema, which may be followed by bronchopneumonia, and occasionally lung abscess. Degenerative changes in the nerves have been reported as later sequelae. Concentrations of 3 to 5 ppm of phosgene in air cause irritation of the eyes and throat, with coughing; 25 ppm is dangerous for exposures lasting 30 to 60 minutes, and 50 ppm is rapidly fatal after even short exposure.

There may be no immediate warning that dangerous concentrations of the gas are being breathed. After a latent period of 2 to 24 hours the patient complains of burning in the throat and chest, shortness of breath and increasing dyspnea. There may be moist rales in the chest. Where the exposure has been severe, the development of pulmonary edema may be so rapid that the patient dies within 36 hours after exposure. In cases where the exposure has been less, pneumonia may develop several days after the occurrence of the accident. In patients who recover, no permanent residual disability is thought to occur.
Disaster Control: Highly dangerous; shock can shatter the compressed gas container with explosive force; when heated to decomposition or on contact with water or steam, it will react to produce toxic and corrosive fumes.
Ventilation Control (use high rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison A; poison gas label.
Coast Guard Classification: Poison A; poison gas label.

PHOSPHAM

Description: White, amorphous crystals.
Formula: PN_2H
Constant:
Mol. Wt. 60.00
Toxicity: Unknown
Disaster Control: Dangerous; on decomposition it emits highly toxic fumes of phosphorus and nitrogen compounds.

PHOSPHENYL CHLORIDE

Synonym: Dichlorophenyl phosphine.
Description: Fuming liquid.
Formula: $C_6H_5PCl_2$
Constants:
Mol. Wt. 179.0
B. P. 225°C
Density 1.319
Vap. D. 6.17
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus and chlorides; will react with water or steam to produce heat, toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

PHOSPHIDES

Composition: Combination of a cation + elemental phosphorus.
Toxicity: Phosphides are particularly dangerous because they tend to decompose to phosphine upon contact with moisture or acids.

See also Phosphine.
Fire Hazard: Dangerous by chemical reaction; they react with water and acids to liberate phosphine.
Explosion Hazard: Moderate. See Phosphine.
Disaster Control: Dangerous; when heated, these may emit highly toxic fumes of oxides of phosphorus; they react with water or steam to produce toxic and flammable vapors; on contact with oxidizing materials, they can react vigorously and on contact with acid or acid fumes, they can emit toxic fumes.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHOSPHINE

Synonyms: Hydrogen phosphide; phosphoretted hydrogen.
Description: Colorless gas.
Formula: PH_3
Constants:
  Mol. Wt. 34.04
  M. P. −132.5°C
  B. P. −87.5°C
  Density 1.529 g/l @.0°C
Toxic Hazard Rating:
  Acute Local: Irritant 2; Inhalation 2
  Acute Systemic: Inhalation 3
  Chronic Local: U
  Chronic Systemic: Inhalation 3
MAC: ACGIH (accepted); 0.05 parts per million in air; 0.07 milligrams per cubic meter of air.
Toxicology: Phosphine is a very toxic gas, but its action on the body has not been fully worked out. It appears to cause, chiefly, a depression of the central nervous system and irritation of the lungs; autopsy findings in human cases may be entirely negative, or there may be pulmonary edema, dilation of the heart and hyperemia of the visceral organs.

Inhalation of phosphine causes restlessness, followed by tremors, fatigue, slight drowsiness, nausea, vomiting, and frequently, severe gastric pain and diarrhea. There is often headache, thirst, dizziness, oppression in the chest and burning substernal pain; later the patient may become dyspneic and develop cough and sputum. Coma or convulsions may precede death. Mild cases recover without after-effects.

Chronic poisoning, characterized by anemia, bronchitis, gastro-intestinal disturbances and visual, speech and motor disturbances, are said to result from continued exposure to very low concentrations.
Fire Hazard: Dangerous, by spontaneous chemical reaction.
To Fight Fire: Carbon dioxide, dry chemical or water spray (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: Not known
Disaster Control: Dangerous; shock can shatter it compressed gas container with explosive force; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PHOSPHONIUM BROMIDE

Description: Cubic, colorless crystals.
Formula: PH_4Br
Constants:
  Mol. Wt. 114.93
  B. P. 38.8°C @794 mm; sublimes approx. 30°C
  Density 2.464 g/l
  Vap. Press. 400 mm @28.0°C
Toxicity: See Bromides.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of bromides.
Storage and Handling: Section 7

PHOSPHONIUM CHLORIDE

Description: Cubic, colorless crystals.
Formula: PH_4Cl
Constants:
  Mol. Wt. 70.47
  M. P. 28°C @46 atm
  B. P. Sublimes

Toxicitiy: See Chlorides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

PHOSPHONIUM IODIDE

Description: Tetragonal, colorless, deliquescent crystals.
Formula: PH_4I
Constants:
Mol. Wt. 161.93
M. P. Sublimes @61.8°C
B. P. 80°C
Density 2.86
Vap. Press. 40 mm @16.1°C
Toxicity: Highly toxic. See Phosphine and Iodides.
Disaster Control: Dangerous; when heated, it emits highly toxic fumes of phosphine, iodides, etc. It explodes on contact with strong oxidizers.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHOSPHONIUM SULFATE

Description: Colorless, deliquescent crystals.
Formula: $(PH_4)_2SO_4$
Constant:
Mol. Wt. 166.09
Toxicity: See Phosphorus Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of sulfur compounds and phosphorus compounds.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHOSPHORAMIDE

Synonym: Phosphoryl amide.
Description: Amorphous, white crystals.
Formula: $PO(NH_2)_3$
Constants:
Mol. Wt. 95.05
M. P. Decomposes
Toxicity: Unknown. See Phosphorus Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen and phosphorus.
Storage and Handling: Section 7

PHOSPHORIC ACID, ORTHO

Description: Colorless liquid or rhombic crystals.
Formula: H_3PO_4
Constants:
Mol. Wt. 98.04
M. P. 42.35°C
$-\frac{1}{2}H_2O$ @213°C
Freezing P. 42.4°C
Density 1.864 @25°C
Vap. Press. 0.0285 mm @20°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: Irritant 2; Inhalation 2
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of oxides of phosphorus.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
MCA warning label

PHOSPHORIC ANHYDRIDE. See Phosphorus Pentoxide.
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.
MCA warning label.

PHOSPHOROUS ACID, META

Description: Feather-like crystals.
Formula: HPO_2
Constant:
Mol. Wt. 63.99
Toxicity: See Phosphorus Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus.
Storage and Handling: Section 7

PHOSPHORUS (AMORPHOUS, RED)

Synonym: Red phosphorus.
Description: Reddish-brown powder.
Formula: P_4
Constants: Mol. Wt. 124.08
B. P. 280°C (with ignition)

M. P. 590°C @43 atmospheres
Density 2.20
Autoign. Temp. 500°F in air
Vap. D. 4.77
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
Fire Hazard: Dangerous, when exposed to heat or by chemical reaction with oxidizers.
Spontaneous Heating: No
To Fight Fire: Water (Section 6).
Explosion Hazard: Moderate, by chemical reaction or on contact with organic materials.
Disaster Control: Dangerous; when heated, it emits highly toxic fumes of oxides of phosphorus; can react with reducing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

PHOSPHORUS CHLORIDE NITRIDE

Description: Prisms.
Formula: $P_6N_7Cl_9$
Constants:
Mol. Wt. 603.05
M. P. 237.5°C
B. P. 251 - 261°C @13 mm
Toxicity: Highly toxic. See Hydrochloric Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus and chlorides; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

PHOSPHORUS COMPOUNDS, INORGANIC

Toxicity: Variable. Most inorganic phosphates, except phosphine, have low toxicity but in large doses they may cause serious disturbances, particularly in calcium metabolism. Metaphosphates may be highly toxic, causing irritation and hemorrhages in the stomach as well as liver and kidney damage.

PHOSPHORUS CYANIDE

Description: White needles.
Formula: $P(CN)_3$
Constants: Mol. Wt. 110
M. P. Sublimes @130°C
Toxicity: Highly toxic. See Cyanides.
Disaster Control: See Cyanides.
Ventilation Control (use moderate rate: Section 2
Storage and Handling: Section 7

PHOSPHORUS DIBROMIDE TRICHLORIDE

Description: Orange crystals.
Formula: PBr_2Cl_3
Constants:
Mol. Wt. 297.18
M. P. 35°C Decomposes
Toxicity: See Hydrobromic Acid and Hydrochloric Acid.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of phosphorus, bromides and chlorides.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHOSPHORUS DIBROMIDE TRIFLUORIDE

Description: Pale yellow crystals.
Formula: PBr_2F_3
Constants:
Mol. Wt. 247.81
M. P. −20°C
B. P. Decomposes @15°C
Toxicity: Highly toxic. See Fluorides and Hydrobromic Acid.
Disaster Control: See Fluorides and Bromides.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHOSPHORUS DICHLORIDE

Description: Colorless crystals.
Formula: PCl_2
Constants: B. P. 180°C
Mol. Wt. 101.89
M. P. −28°C

Toxicity: Probably toxic. See Hydrochloric Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus and chlorides; will react with water, steam or acids to produce toxic and corrosive fumes;
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHOSPHORUS DICHLORIDE TRIFLUORIDE

Formula: PCl_2F_3
Constants:
Mol. Wt. 158.89
B. P. −8°C; decomp. @ 200°C
Toxicity: Probably toxic. See Fluorides and Hydrochloric Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides, oxides of phosphorus and chlorides; will react with water, steam or acids to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHOSPHORUS DIIODIDE

Description: Crystals.
Formula: P_2I_4
Constants:
Mol. Wt. 569.64
M. P. 124.5°C
B. P. Decomposes
Toxicity: Probably toxic. See Iodides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus and iodides; will react with water, steam, or acids to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHOSPHORUS HEMITRISELENIDE

Description: Dark red mass.
Formula: P_2Se_3
Constant:
Mol. Wt. 298.8
Toxicity: See Selenium Compounds.
Fire Hazard: Moderate, by chemical reaction.
Explosion Hazard: Moderate, by chemical reaction.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of selenium and oxides of phosphorus.
Ventilation Control (use moderate rate): Section 2

PHOSPHORUS HEPTABROMIDE DICHLORIDE

Description: Prisms.
Formula: PBr_7Cl_2
Constant:
Mol. Wt. 661.31
Toxicity: Probably toxic. See Hydrochloric Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromides and chlorides; will react with water, steam or acids to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHOSPHORUS HEPTASULFIDE

Description: Solid, light yellow crystals; light gray powder or fused solid.
Formula: P_4S_7
Constants:
Mol. Wt. 348.34
M. P. 310°C
B. P. 523°C
Density 2.19 @ 17°C
Toxicity: See Sulfides and Phosphorus Compounds.
Fire Hazard: Dangerous. See Sulfides.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride.
Explosion Hazard: Moderate. See Sulfides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; will react with water, steam or acids to produce toxic and flammable vapors; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHOSPHORUS MONOBROMIDE TETRACHLORIDE

Description: Yellow crystals.
Formula: $PBrCl_4$
Constant:
Mol. Wt. 252.72
Toxicity: Probably toxic. See Hydrochloric Acid and Bromides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and bromides; will react with water, steam or acids to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHOSPHORUS NITRIDE

Description: Amorphous, white crystals.
Formula: P_3N_5
Constants:
Mol. Wt. 162.98
B. P. Decomposes @ 800°C
Density 2.51 @ 18°C
Toxicity: Probably toxic. See Phosphorus Compounds, Inorganic.
Fire Hazard: Moderate, by chemical reaction. See Ammonia.
Explosion Hazard: Moderate, by chemical reaction.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of nitrogen and phosphorus; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHOSPHORUS OXYBROMIDE

Description: Colorless plates.
Formula: $POBr_3$
Constants:
Mol. Wt. 286.73
M. P. 56°C
B. P. 193°C
Density 2.882
Toxicity: Probably toxic. See Hydrobromic Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromides and oxides of phosphorus; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHOSPHORUS OXYCHLORIDE

Synonym: Phosphoryl chloride.
Description: Colorless to slightly yellow fuming liquid.
Formula: $POCl_3$
Constants:
Mol. Wt. 153.39
M. P. 2°C
B. P. 105.1°C
Density 1.685 @ 15.5°C
Vap. Press. 40 mm @ 27.3°C
Vap. D. 5.3
Toxicity: Highly toxic. See Hydrochloric Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of phosphorus; will react with water or steam to produce heat and toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.
MCA warning label.

PHOSPHORUS OXYFLUORIDE

Description: Colorless gas.
Formula: POF_3
Constants:
Mol. Wt. 103.98
M. P. -68°C
B. P. -39.8°C
Density 4.69 g/l
Toxicity: Highly toxic. See Fluorides and Hydrofluoric Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides; will react with water, steam or acids to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHOSPHORUS OXYNITRIDE

Description: Amorphous,

white crystals.
Formula: PON
Constants:
Mol. Wt. 60.99
M. P. Red heat
Toxicity: See Nitrides.
Fire Hazard: Moderate, by chemical reaction (See Ammonia).
Explosion Hazard: Moderate, by chemical reaction.
Disaster Control: Dangerous; on decomposition it emits highly toxic fumes of oxides of phosphorus and nitrogen; on contact with acid or acid fumes, it can emit toxic fumes.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

PHOSPHORUS OXYSULFIDE

Description: Tetragonal, deliquescent crystals.
Formula: $P_4O_6S_4$
Constants: Mol. Wt. 348.18
M. P. 102°C
B. P. 295°C
Toxicity: See Sulfides.
Fire Hazard: Moderate. See Sulfides.
Explosion Hazard: Moderate. See Sulfides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur and phosphorus.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHOSPHORUS PENTABROMIDE

Description: Rhombic, yellow crystals.
Formula: PBr_5
Constants:
Mol. Wt. 430.56
M. P. Decomposes above 100°C
B. P. Decomposes @106°C
Toxicity: Highly caustic. See Bromides.
Fire Hazard: Moderate by chemical reaction. Contact with moisture can cause a violent reaction and evolution of heat.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromides; will react with water or steam to produce heat and toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Storage and Handling Section 7

PHOSPHORUS PENTACHLORIDE

Description: Yellowish-white, fuming, crystalline mass.
Formula: PCl_5
Constants:
Mol. Wt. 208.31
M. P. 166.8°C
B. P. Sublimes @162°C
Density 4.65 g/liter @296°C
Vap. Press. 1 mm @55.5°C
Toxicity: Highly caustic. See Hydrochloric Acid.
MAC: ACGIH (accepted); 1 milligram per cubic meter of air.
Fire Hazard: Moderate, by chemical reaction. Reacts violently with moisture.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; will react with water or steam to produce heat and toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.
MCA warning label

PHOSPHORUS PENTAFLUORIDE

Description: Colorless gas.
Formula: PF_5
Constants: Mol. Wt. 125.98
M. P. −93.7°C
B. P. −84.5°C
Vap. D. 5.81 g/l
Toxicity: Highly toxic. See Fluorides.
Disaster Control: Dangerous; shock can shatter its compressed gas container; when heated to decomposition, it emits highly toxic fumes of fluorides and phosphorus compounds; will react with water or steam to produce toxic and corrosive fumes.

Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHOSPHORUS PENTASELENIDE

Synonym: Diphosphorus pentaselenide.
Description: Dark red-black needles.
Formula: P_2Se_5
Constants:
Mol. Wt. 456.76
M. P. Decomposes
Toxicity: Probably toxic. See Selenium Compounds.
Fire Hazard: Moderate. See Selenium Compounds.
Explosion Hazard: See Selenium Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of phosphorus and selenium.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHOSPHORUS PENTASULFIDE

Description: Gray to yellow-green, crystalline, deliquescent mass.
Formula: P_2S_5
Constants:
Mol. Wt. 222.34
M. P. 276°C
B. P. 514°C
Density 2.03
Autoign. Temp. 548.6°F
Toxicity: Probably toxic. See Sulfides.
MAC: ACGIH (accepted); 1 milligram per cubic meter of air.
Fire Hazard: Dangerous in the form of dust when exposed to heat or flame. Evolves heat in contact with moisture.
Spontaneous Heating: Yes, in the presence of moisture.
To Fight Fire: Carbon dioxide, snow dry chemical or sand.
Explosion Hazard: Moderate, in solid form by spontaneous chemical reaction.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur and phosphorus; will react with water, steam or acids to produce toxic and flammable vapors; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHOSPHORUS PENTOXIDE

Synonym: Phosphoric acid anhydride.
Description: A fluffy, crystalline, deliquescent powder.
Formula: P_2O_5
Constants:
Mol. Wt. 143.0
M. P. 563°C
B. P. 347°C (sublimes)
Density 0.77 - 1.39
Vap. Press. 1 mm @384°C
Toxicity: Highly caustic. See Phosphorus Compounds, Inorganic.
Fire Hazard: Moderate, by chemical reaction. Reacts violently with water to evolve heat (Section 6).
Disaster Control: Dangerous; it reacts with water or steam to produce heat; on contact with reducing materials, it can react vigorously.
Storage and Handling: Section 7

PHOSPHORUS SESQUISULFIDE

Synonym: Tetraphosphorus trisulfide.
Description: Yellow, crystalline mass.
Formula: P_4S_3
Constants:
Mol. Wt. 220.26
M. P. 172.5°C
B. P. 407°C
Density 2.03
Autoign. Temp. 212°F
Toxicity: Probably toxic. See Sulfides.
Fire Hazard: Dangerous, when exposed to heat or flame; ignites by friction.
Spontaneous Heating: No
To Fight Fire: Water (Section 6).
Explosion Hazard: Moderate by chemical reaction.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus and sulfur; will react with water or steam to produce toxic fumes; can react vigorously with oxidizing materials.

Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid; yellow label.

PHOSPHORUS TETROXIDE

Description: Rhombic, colorless, deliquescent crystals.
Formula: P_2O_4
Constants:
  Mol. Wt. 125.96
  M. P. > 100°C
  B. P. Sublimes @180°C
  Density 2.54 @23°C
Toxicity: See Phosphorus Compounds, Inorganic.

PHOSPHORUS THIOCYANATE

Description: Liquid.
Formula: $P(SCN)_3$
Constants:
  Mol. Wt. 205.23
  M. P. Approx. -4°C
  B. P. 265°C
  Density 1.625 @18°C
Toxicity: Probably toxic. See Thiocyanates.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acids, it emits highly toxic fumes of cyanides; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHOSPHORUS TRIBROMIDE

Description: Colorless, fuming liquid.
Formula: PBr_3
Constants:
  Mol. Wt. 270.8
  M. P. -40°C
  B. P. 175.3°C
  Density 2.852 @15°C
  Vap. Press. 10 mm @47.8°C
Toxicity: See Hydrobromic Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromides and oxides of phosphorus; will react with water, steam or acids to produce heat and toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Corrosive liquid; white label.
  Coast Guard Classification: Corrosive liquid; white label.

PHOSPHORUS TRICHLORIDE

Synonym: Phosphorus chloride.
Description: Clear, colorless, fuming liquid.
Formula: PCl_3
Constants:
  Mol. Wt. 137.39
  M. P. -111.8°C
  B. P. 74.2°C
  Density 1.574 @21°C
  Vap. Press. 100 mm @21°C
  Vap. D. 4.75
Toxicity: Highly toxic. See Hydrochloric Acid.
MAC: ACGIH (accepted); 0.5 parts per million in air; 3 milligrams per cubic meter of air.
Fire Hazard: Moderate, by chemical reaction.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of phosphorus; will react with water, steam, or acids to produce heat and toxic and corrosive fumes; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Corrosive liquid; white label.
  Coast Guard Classification: Corrosive liquid; white label.
  MCA warning label

PHOSPHORUS TRIFLUORIDE

Description: Colorless gas.
Formula: PF_3
Constants:
  Mol. Wt. 87.98

M. P. -160°C
B. P. -95°C
Density 3.907 g/l
Toxicity: Highly toxic. See Hydrofluoric Acid and Fluorides.
Disaster Control: Dangerous; shock can shatter the compressed gas container, releasing the contents; when heated to decomposition it emits highly toxic fumes of fluorides and oxides of phosphorus; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHOSPHORUS TRIIODIDE

Description: Hexagonal, red, deliquescent crystals.
Formula: PI_3
Constants:
Mol. Wt. 411.74
M. P. 61°C
B. P. Decomposes
Toxicity: See Iodides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of iodides and oxides of phosphorus.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHOSPHORUS TRIOXIDE

Description: Monoclinic, colorless crystals or white, deliquescent powder.
Formula: P_2O_3
Constants:
Mol. Wt. 110.0
M. P. 22.5°C
B. P. 173°C
Density 2.135 @21°C
Vap. Press. 10 mm @53.0°C
Toxicity: Caustic. See Phosphorus Compounds, Inorganic.
Disaster Control: Slightly dangerous; will react with water or steam to produce heat.
Storage and Handling: Section 7

PHOSPHORUS TRISULFIDE

Synonym: Tetraphosphorus hexasulfide.
Description: Gray-yellow crystals.
Formula: P_4S_6
Constants:
Mol. Wt. 316.44
M. P. 290°C
B. P. 490°C
Toxicity: Probably toxic. See Sulfides.
Fire Hazard: Moderate, when exposed to heat or by chemical reaction (Section 6).
Explosion Hazard: Moderate, by chemical reaction.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus and sulfides; will react with water or steam to produce toxic fumes; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PHOSPHORUS (WHITE)

Description: Cubic crystals; colorless to yellow, wax-like solid.
Formula: P_4
Constants:
Mol. Wt. 124.08
M. P. 44.1°C
B. P. 280°C
Flash P. Spontaneously in air
Density 1.82
Autoign. Temp. 86°F
Vap. Press. 1 mm @76.6°C
Vap. D. 4.42
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3
MAC: ACGIH (accepted); 0.1 milligrams per cubic meter of air.
Toxicology: This material is dangerously reactive in air and turns red in sunlight. If combustion occurs in a confined space, it will remove the oxygen and render the air unfit to support life. High concentrations of the vapors evolved by burning it are irritating to the nose, throat and lungs as well as the skin, eyes and mucous membranes. If phosphorus is ingested, it can be absorbed from the

gastrointestinal tract or through the lungs. The absorption of toxic quantities of phosphorus has an acute effect on the liver and is accompanied by vomiting and marked weakness. The long-continued absorption of small amounts of phosphorus can result in necrosis of the mandible or jaw bone, and is known as "phossy-jaw." Long-continued absorption, particularly through the lungs, and through the gastrointestinal tract can cause a chronic poisoning. This gives rise to a generalized form of weakness attended by anemia, loss of appetite, gastrointestinal weakness and pallor. The most common symptom, however, of chronic phosphorus poisoning is necrosis of the jaw. It can also cause changes in the long bones, and seriously affected bones may become brittle, leading to spontaneous fractures. It is especially hazardous to the eyes and can damage them severely. It also has adverse effects on the teeth, and workers should have periodic dental examinations. The yellow form of phosphorus, when it comes into external contact with the eyes, can cause conjunctivitis with a yellow tint. If the material is inhaled, it can cause photophobia with myosis, dilation of pupils, retinal hemorrhage, congestion of the blood vessels and rarely an optic neuritis.

Radiation Hazard (Section 5): Artificial isotope P^{32}, half-life: 14.4 days; emits beta particles of 1.71 mev. The permissible levels are: In body: 10 microcuries; in air: 10^{-7} microcurie per milliliter; in water: 2×10^{-4} microcurie per milliliter.
Hazard Rating, Class II (National Bureau of Standards Handbook No. 42).

Fire Hazard: Dangerous, when exposed to heat or by chemical reaction with oxidizers. Ignites spontaneously in air.

Spontaneous Heating: No

To Fight Fire: Water.

Explosion Hazard: Moderate, by chemical reaction with oxidizing agents.

Disaster Control: Dangerous; it emits highly toxic fumes of oxides of phosphorus; can react vigorously with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

Shipping Regulations: Section 11.
White or yellow - dry, in water for both I.C.C. and Coast Guard.
I.C.C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.
MCA warning label.

PHOSPHOTUNGSTIC ACID

Description: Triclinic, yellow-green crystals.

Formula: $H_3PW_{12}O_{40} \cdot 14H_2O$

Constant: Mol. Wt. 3133.27

Toxicity: Slight. See Tungsten Compounds.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of phosphorus.

Storage and Handling: Section 7

PHOTOGRAPHIC AND X-RAY FILMS, SCRAP

Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).

Disaster Control: Dangerous; when heated to decomposition, they emit highly toxic fumes; they can react vigorously with oxidizing materials.

Storage and Handling: Section 7

Shipping Regulations: Section 11.
I.C.C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

PHTHALIC ACID

Synonym: Benzene dicarboxylic acid.

Description: Crystals.

Formula: $C_8H_6O_4$

Constants: Mol. Wt. 166.1
M. P. 206 - 208°C
Density 1.59

Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U

Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

PHTHALIC ANHYDRIDE

Synonym: Phthalandione.
Description: White crystalline needles.
Formula: $C_6H_4(CO)_2O$
Constants:
- Mol. Wt. 148.11
- M. P. 131.2°C
- B. P. 284.5°C Sublimes
- Flash P. 305°F (C.C.)
- Density 1.527 @4°C
- Autoign. Temp. 1083°F
- Vap. Press. 1 mm @96.5°C
- Vap. D. 5.10

Toxic Hazard Rating:
- Acute Local: Irritant 1; Ingestion 1; Inhalation 1
- Acute Systemic: U
- Chronic Local: Irritant 1; Inhalation 1
- Chronic Systemic: U

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, in the form of dust, when exposed to flame.
Explosive Range: 1.7 - 10.4%
Personal Hygiene: Section 3
Storage and Handling: Section 7
MCA warning label

PHTHALIDE

Synonym: α-Hydroxy-o-toluic acid lactone.
Description: White crystals.
Formula:

$\underbrace{C_6H_4CO_2CH_2}$

Constants:
- Mol. Wt. 134.1
- M. P. 72.7°C
- B. P. 290 - 292°C
- Vap. Press. 1 mm @95.5°C

Toxicity: Unknown
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

PHTHALIMIDE

Synonym: 1,3-Isoindole dione.
Description: Light tan to white powder.
Formula: $C_6H_4(CO)_2NH$
Constants:
- Mol. Wt. 147.1
- M. P. 233°C
- B. P. Sublimes

Toxicity: Unknown
Fire Hazard: Slight; when heated, to decomposition it emits toxic fumes (Section 6).
Storage and Handling: Section 7

PHTHALONITRILE

Synonym: o-Dicyanobenzene.
Description: Powder.
Formula: $C_6H_4(CN_2)_2$
Constant:
- Mol. Wt. 156.2

Toxicity: Highly toxic. See Cyanides.
Disaster Control: Dangerous. See Cyanides.
Storage and Handling: Section 7

PHYSOSTIGMA

Synonyms: Calabar bean; ordeal bean.
Description: Dried, ripe seeds.
Toxic Hazard Rating:
- Acute Local: Allergen 1
- Acute Systemic: Ingestion 3; Inhalation 3
- Chronic Local: Allergen 1
- Chronic Systemic: U

Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

PHYSOSTIGMINE

Synonyms: Eserine; calabarine.
Description: Colorless, hygroscopic crystals.
Formula: $C_{15}H_{21}N_3O_2$
Constants:
- Mol. Wt. 275.3
- M. P. 105 - 106°C

Toxic Hazard Rating:
- Acute Local: Allergen 1
- Acute Systemic: Ingestion 3
- Chronic Local: U
- Chronic Systemic: U

Toxicology: Poisoning can occur as the result of a mistake in dosage or due to hypersensitivity of the patient. Symptoms of intoxication from this material, which usually manifest themselves in from 5 to 25 minutes after injection, are a marked cutaneous hyperaesthesia, vomiting, convulsions and diarrhea, paralysis of the diaphragm, spasm of the glottis with transient dyspnea, increased salivation, sweating, slowing of the respiration and lowering of the temperature. Death usually occurs from respiratory paralysis. It has a central and peripheral nervous system action.

Treatment and Antidotes: Wash out stomach, keep body warm. Atropine by injection. Artificial respiration and oxygen if needed.

Fire Hazard: Slight; when heated to decomposition, it emits toxic fumes of nitrogen oxides.

α-PICOLINE

Synonym: Alpha-methyl pyridine.
Description: Colorless liquid, strong, unpleasant odor.
Formula: $C_5H_4NCH_3$
Constants:
- Mol. Wt. 93.13
- M. P. -70°C
- B. P. 129°C
- Flash P. 85°F (O.C.)
- Density 0.95 @15°/4°C
- Autoign. Temp. 1000°F
- Vap. Press. 10 mm @24.4°C

Toxicity: Details unknown. See Pyridine.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition it emits toxic fumes of nitrogen oxides.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

β-PICOLINE

Synonyms: 3-Picoline; 3-methyl pyridine.
Description: Colorless liquid.
Formula: $CH_3C_5H_4N$
Constants:
- Mol. Wt. 93.12
- B. P. 143.5°C
- Density 0.9613 @15°/4°C
- Vap. D. 3.21

Toxicity: Details unknown. See Pyridine.
Fire Hazard: Details unknown. Probably moderate to dangerous.
Disaster Control: Dangerous, when heated to decomposition it emits toxic fumes of nitrogen oxides.

γ-PICOLINE

Synonyms: 4-Picoline; 4-methyl pyridine.
Description: Colorless liquid.
Formula: $CH_3C_5H_4N$
Constants:
- Mol. Wt. 93.06
- B. P. 145°C
- Freezing P. 3.7°C
- Density 0.9571 @15°/4°C
- Vap. D. 3.21

Toxicity: Details unknown. See Pyridine.
Fire Hazard: Probably moderate to dangerous.
Disaster Control: See α-Picoline.

4-PICOLINE-N-OXIDE

Description: Crystals.
Formula: C_6H_7NO
Constants:
- Mol. Wt. 109.1
- Freezing P. 186.3°C

Toxicity: Details unknown. See Pyridine.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react with oxidizing materials.
Storage and Handling: Section 7

PICRAMIC ACID

Synonyms: Picraminic acid; dinitroaminophenol.
Description: Red, monoclinic crystals.
Formula: $NH_2(NO_2)_2C_6H_2OH$
Constants:
- Mol. Wt. 199.12
- M. P. 168 - 169°C

Toxicity: Unknown
Fire Hazard: Moderate. See Nitrates.
Explosion Hazard: Moderate. See Nitrates.

Disaster Control: Dangerous. See Nitrates.
Storage and Handling: Section 7

PICRATES. See Nitrates.

PICRATOL

Synonyms: Silver picrate.
Description: Yellow, crystalline powder.
Formula: $C_6H_2O(NO_2)_3Ag \cdot H_2O$
Constant:
 Mol. Wt. 353.9
Toxicity: See Picric Acid.
Fire Hazard: Moderate. See Nitrates.
Explosion Hazard: Severe. See Nitrates and Explosives, High.
Disaster Control: Dangerous. See Nitrates and Explosives, High.
Storage and Handling: Section 7

PICRIC ACID

Synonym: Picronitric acid; trinitrophenol; carbazotic acid.
Description: Yellow crystals or yellow liquid.
Formula: $(NO_2)_3C_6H_2OH$
Constants:
 Mol. Wt. 229.11
 M. P. 121.8°C
 B. P. Explodes above 300°C
 Flash P. 302°F
 Density 1.763
 Autoign. Temp. 572°F
 Vap. D. 7.90
Toxic Hazard Rating:
 Acute Local: Irritant 2; Allergen 1
 Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 2
 Chronic Local: Irritant 2; Allergen 2
 Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
MAC: ACGIH (tentative); 0.1 milligrams per cubic meter in air.
Fire Hazard: Slight, but explodes @ 300°C. An oxidizing material.
Spontaneous Heating: No
To Fight Fire: Water
Explosion Hazard: Dangerous, when shocked or exposed to heat (See Explosives, High). Picric acid forms salts readily. Many of its salts, known as picrates, are more sensitive explosives than picric acid. This is particularly true of copper, lead and zinc. Therefore, this material must be kept out of contact with metals. Picric acid is a more powerful explosive than TNT. Its ability to form the sensitive picrates in contact with metal has somewhat limited its usefulness as an explosive. In America, its primary use is in the converted form of ammonium picrate in base-fused shells for seacoast cannon and in all armor-piercing shells.
 Picric acid has also found use as a booster explosive and as a substitute for a part of the mercury fulminate change in detonators.
 It has been used extensively in the form of mixtures with other nitro compounds. Such mixtures, having a lower melting point than picric acid, can be melted and cast at temperatures below 100°C. These mixtures are more generally practical for use because of the hazard involved in melting straight picric acid, which has a relatively high melting temperature. Guanidine picrate is an example of a picrate which is used in shells instead of pure picric acid. See also Explosives, High.
Disaster Control: Highly dangerous; shock will explode it; on decomposition, it emits highly toxic fumes and explodes; can react vigorously with reducing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PICRIC ACID, WET, NOT EXCEEDING 16 OUNCES. See Picric Acid.
Shipping Regulations: Section 11.
 I. C. C. Classification: See Section 11, §73.192.
 Coast Guard Classification: Inflammable solid.

PICRIC ACID, WET WITH NOT LESS THAN 10% WATER. See Picric Acid.
Shipping Regulations: Section 11.
 I. C. C. Classification: Flammable solid; yellow label.

Coast Guard Classification: Inflammable solid; yellow label.

PICRYL CHLORIDE

Synonym: 2-Chloro-1, 3, 5-trinitrobenzene.
Description: White needles.
Formula: $C_6H_2ClN_3O_6$
Constants:
Mol. Wt. 247.6
M. P. 83°C
Density 1.797
Toxicity: Details unknown. See also Picric Acid.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

PICRYL SULFIDE

Toxicity: Details unknown. See also Picric Acid.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: See Sulfides and Nitrates.
Storage and Handling: Section 7

PILOCARPINE

Description: Colorless or yellow, hygroscopic, needle-like crystals.
Formula: $C_{11}H_{16}N_2O_2$
Constants:
Mol. Wt. 208.26
M. P. 34°C
B. P. 260°C @5 mm
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Toxicology: A very poisonous alkaloid. It can cause contraction of the pupils and lachrymation. The ingestion of toxic quantities of this material causes a marked secretion of saliva, excessive perspiration and tears, nausea, retching and vomiting, pain in the abdomen, violent movement of the intestines with profuse watery evacuation. The pulse is sometimes quickened, sometimes slow and irregular. The respiration is quick and labored with rales over the bronchi. There are giddiness and confusion with tremors and feeble convulsions. Eventually slower respiration and weakness occur, but consciousness remains until breathing ceases. The action of pilocarpine on the sweat glands renders it the most powerful sudorific in the pharmacopeia. It is used to remove excess fluid accumulations in the body. It very rarely causes death but when it does, it is by paralysis of the heart or edema of the lungs.
Treatment and Antidotes: Give general treatment for alkaloidal poisoning and in addition atropine may be administered.
Disaster Control: Dangerous; on heating to decomposition it emits toxic fumes of nitrogen oxides.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

"PINAP"

Constant:
Flash P. 80°F (C.C.)
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PINENE

Synonym: α-Pinene.
Description: Liquid; odor of turpentine.
Formula: $C_{10}H_{16}$
Constants: Mol. Wt. 136.2
M. P. -55°C
B. P. 155°C
Flash P. 91°F
Density 0.8585 @20°/4°C
Vap. Press. 10 mm @37.3°C
Toxicity: A weak allergen. See also Turpentine.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

PINE OIL

Description: Pale yellow liquid; penetrating odor.

Constants:

B. P. 200 - 220°C
Flash P. 172°F (C.C.)
Density 0.86

Toxicity: A weak allergen. See also Turpentine.

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.

Spontaneous Heating: Moderate

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Ventilation Control (use normal rate): Section 2

Storage and Handling: Section 7

Shipping Regulations: Section 11.
Coast Guard Classification: Combustible liquid.

PINE PITCH

Constants:

M. P. 64.4°C
B. P. 255°C
Flash P. 285°F (C.C.)

Toxicity: A weak allergen.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

Spontaneous Heating: Yes

To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

PINE RESIN

Synonyms: Colophony; yellow resin; rosin.

Description: Pale to yellow to amber, translucent fragments; slight turpentine odor and taste.

Constants:

M. P. 100 - 150°C
Flash P. 370°F
Density 1.08

Toxicity: Details unknown; may act as a weak allergen.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

Spontaneous Heating: Yes

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

PINE TAR

Description: Black-brown, viscous liquid; piny odor.

Constants:

B. P. 240 - 400°C
Flash P. 130°F (C.C.)
Density Above 1
Autoign. Temp. 671°F

Toxic Hazard Rating:

Acute Local: Irritant 1; Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.

Spontaneous Heating: Yes

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Personal Hygiene: Section 3

Ventilation Control (use normal rate): Section 2

Storage and Handling: Section 7

PINE TAR OIL

Synonym: Tar oil rectified.

Description: Dark, reddish-brown liquid.

Constants:

Flash P. 144°F (C.C.)
Density 0.96 - 0.99 @25°/25°C

Toxic Hazard Rating:

Acute Local: Irritant 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Personal Hygiene: Section 3

Storage and Handling: Section 7

PINTSCH GAS

Typical Composition: 30.0% illuminants, 0.1% carbon monoxide, 13.2% hydrogen, 45.0% methane, 9.0% ethane, 0.2% carbon dioxide, 1.6% nitrogen.

Toxic Hazard Rating:

Acute Local: U
Acute Systemic: Inhalation 2
Chronic Local: U
Chronic Systemic: Inhalation 1

Fire Hazard: Moderate, when exposed to flame (Section 6).
Explosion Hazard: Unknown
Disaster Control: Moderately dangerous; shock can shatter its compressed gas container, releasing the contents; when heated, it emits toxic fumes; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

PIPERAZINE

Synonyms: Hexahydropyrazine; diethylenediamine.
Description: Colorless, rhombic crystals.
Formula: $\underline{NHCH_2CH_2NHCH_2CH_2}$
Constants:
  Mol. Wt. 86.14
  M. P. 104°C
  B. P. 145°C
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 1
  Chronic Local: U
  Chronic Systemic: Ingestion 1
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen.
Personal Hygiene: Section 3
Storage and Handling: Section 7

PIPERIDINE

Synonym: Hexahydropyridine.
Description: Clear, colorless liquid; amine-like odor.
Formula: $C_5H_{11}N$
Constants:
  Mol. Wt. 85.2
  M. P. −7°C
  B. P. 106°C
  Flash P. 61°F
  Density 0.8622 @20°/4°C
  Vap. Press. 40 mm @29.2°C
  Vap. D. 3.0
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PIPERIDINIUM PENTAMETHYLENE DITHIOCARBAMATE

Description: White to cream crystals.
Formula: $C_{11}H_{22}N_2S_2$
Constants:
  Mol. Wt. 246
  M. P. 170°C
  Density 1.13 @25°C
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 1
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur and nitrogen.
Personal Hygiene: Section 3
Storage and Handling: Section 7

PIPERINE

Synonym: 1-Piperoyl piperidine.
Description: Crystals.
Formula: $C_{17}H_{19}NO_3$
Constants: Mol. Wt. 285.3
  M. P. 130°C
  Density 1.193
Toxicity: Details unknown; an insecticide. Probably low.
Disaster Control: Dangerous; when heated to decompositon, it emits highly toxic fumes of oxides of nitrogen.
Storage and Handling: Section 7

PIPERONAL

Synonyms: 3,4-Methylene-dioxybenzaldehyde; heliotropin.
Description: Colorless, lustrous crystals.
Formula: $C_8H_6O_3$
Constants:
  Mol. Wt. 150.1
  M. P. 37°C
  B. P. 263°C
  Vap. Press. 1 mm @87.0°C
Toxicity: Details unknown; a mosquito repellent. See also Aldehydes.
Fire Hazard: Slight, when exposed

to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

PIPERONYL BUTOXIDE

Synonym: Butylcarbityl (6-propyl piperonyl) ether.
Description: Light brown liquid; mild odor.
Formula: $C_{12}H_{15}O_3$
Constants:
  Mol. Wt. 207.2
  Flash P. 340°F
  Density 1.04 - 1.07 @20°/20°C
Toxicity: Details unknown; probably low; an insecticide.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

PIPERONYL CYCLONENE

Synonym: 3-Isoamyl-5-(methylene dioxyphenyl)-2-cyclohexanone.
Description: Powder.
Formula: $C_5H_{11}CH_2(OC_6H_5)_2C_6H_8O$
Constants:
  Mol. Wt. 367.5
  Flash P. 290 - 300°F
  Density 1.09 - 1.20 @20°/20°C
Toxicity: Probably low.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

PITCH DUST

Toxic Hazard Rating:
  Acute Local: Irritant 2
  Acute Systemic: U
  Chronic Local: Irritant 2
  Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Slight, when exposed to flame.
Personnel Protection: Section 3
Personal Hygiene: Section 3

PLASTIC POWDERS

Toxicity: Variable; a weak allergen.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Moderately dangerous; when heated, they burn and may emit acrid fumes; they may react with oxidizing materials.
Storage and Handling: Section 7

PLATINIC DISULFIDE

Description: Black-brown powder.
Formula: PtS_2
Constants:
  Mol. Wt. 259.36
  M. P. Decomp. 225 - 250°C
  Density 7.22
Toxicity: See Platinum Compounds and Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: Moderate. See Sulfides.
Disaster Control: Dangerous. See Sulfides.
Storage and Handling: Section 7

PLATINIC TETRABROMIDE

Description: Dark brown crystals.
Formula: $PtBr_4$
Constants:
  Mol. Wt. 514.89
  M. P. Decomp. @180°C
  Density 5.69
Toxicity: See Platinum Compounds.
Disaster Control: See Bromides.
Storage and Handling: Section 7

PLATINIC TETRACHLORIDE

Description: Brown-red crystals.
Formula: $PtCl_4$
Constants:
  Mol. Wt. 337.06
  M. P. Decomp. @370°C
Toxicity: See Platinum Compounds.
Disaster Control: See Chlorides.
Storage and Handling: Section 7

PLATINIC TETRAFLUORIDE

Description: Deep, red, fused mass or yellow-light brown, deliquescent crystals.
Formula: PtF_4
Constants:
  Mol. Wt. 271.23
  M. P. Decomposes
Toxicity: See Fluorides
Disaster Control: Dangerous. See Fluorides.
Storage and Handling: Section 7

PLATINIC TETRAIODIDE

Description: Amorphous, brown to black crystals.
Formula: PtI_4
Constants:
Mol. Wt. 702.91
M. P. Decomp. @370°C
Density 6.064 @25°C
Toxicity: See Platinum Compounds.
Disaster Control: See Iodides.
Storage and Handling: Section 7

PLATINOUS-AMMONIUM CHLORIDE

Synonym: Ammonium chloroplatinite.
Description: Dark ruby-red crystals.
Formula: $PtCl_2 \cdot 2NH_4Cl$
Constants:
Mol. Wt. 373.14
M. P. Decomposes
Density 2.936
Toxicity: See Platinum Compounds.

PLATINOUS CYANIDE

Description: Yellow-brown crystals.
Formula: $Pt(CN)_2$
Constant:
Mol. Wt. 247.27
Toxicity: Highly toxic. See Cyanides.
Disaster Control: Dangerous. See Cyanides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PLATINOUS DIBROMIDE

Description: Brown crystals.
Formula: $PtBr_2$
Constants:
Mol. Wt. 355.06
M. P. Decomp. @250°C
Density 6.65
Toxicity: See Platinum Compounds.
Disaster Control: See Bromides.
Storage and Handling: Section 7

PLATINOUS DICHLORIDE

Description: Olive green crystals.
Formula: $PtCl_2$
Constants:
Mol. Wt. 266.14
M. P. Decomp. @581°C
Density 5.87 @11°C
Toxicity: See Platinum Compounds.
Disaster Control: Dangerous. See Chlorides.
Storage and Handling: Section 7

PLATINOUS DIFLUORIDE

Description: Yellowish-green crystals.
Formula: PtF_2
Constant:
Mol. Wt. 233.23
Toxicity: See Fluorides.
Disaster Control: Dangerous. See Fluorides.
Storage and Handling: Section 7

PLATINOUS DIIODIDE

Description: Black crystals.
Formula: PtI_2
Constants:
Mol. Wt. 449.07
M. P. Decomp. 300 - 350°C
Density 6.4
Toxicity: See Platinum Compounds and Sulfides.
Disaster Control: See Iodides.
Storage and Handling: Section 7

PLATINOUS MONOSULFIDE

Description: Black crystals.
Formula: PtS
Constants: Mol. Wt. 227.29
M. P. Decomposes
Density 8.847
Toxicity: See Platinum Compounds.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

PLATINUM ARSENIDE

Synonym: Sperrylite.
Description: Cubic, white crystals.
Formula: $PtAs_2$
Constants:
Mol. Wt. 345.05
M. P. > 800°C
Density 10.602
Toxicity: Highly toxic. See Arsenic Compounds.
Fire Hazard: Moderate, by chemical reaction (Section 6).
Explosion Hazard: Moderate, by chemical reaction.
Disaster Control: Dangerous. See Arsenic Compounds.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3

Personal Hygiene: Section 3
Storage and Handling: Section 7

PLATINUM COMPOUNDS

Toxicity: Exposure to complex platinum salts has been shown to cause symptoms of intoxication such as wheezing, coughing, running of the nose, tightness in the chest, shortness of breath and cyanosis, whereas exposure to dust of pure metallic platinum causes no intoxication. Furthermore, many people working with platinum salts are troubled with dermatitis (Section 9). This seems only to be true of complex platinum salts. It does not include the complex salts of other precious metals.
Treatment and Antidotes: Removal from exposure effectively causes the symptoms to disappear.
Radiation Hazard (Section 5): Artificial isotope Pt^{197}, half-life: 18 hours; emits beta particles of 0.68 mev.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3

PLATINUM FULMINATE

Description: Solid.
Formula: $Pt(C_2N_2O_2)_2$
Constant:
Mol. Wt. 363.3
Toxicity: See Platinum Compounds.
Fire Hazard: Unknown
Explosion Hazard: Severe, when shocked or exposed to heat. See also Explosives, High and Fulminates.
Disaster Control: Dangerous; shock will explode it; when heated to decomposition it emits highly toxic fumes of oxides of nitrogen.
Storage and Handling: Section 7

PLATINUM PYROPHOSPHATE

Description: Green-yellow crystals.
Formula: PtP_2O_7
Constants:
Mol. Wt. 369.27
M. P. Decomp. @600°C
Density 4.85
Toxicity: Probably slight.

PLATINUM SESQUISULFIDE

Description: Gray crystals (exist. quest.)
Formula: Pt_2S_3
Constants:
Mol. Wt. 486.66
M. P. Decomposes
Density 5.52
Toxicity: See Platinum Compounds and Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: Moderate. See Sulfides.
Disaster Control: Dangerous. See Sulfides.
Storage and Handling: Section 7

PLUTONIUM

Description: Radioactive metallic element.
Formula: Pu
Constant: At. Wt. 239
Toxicity: Highly toxic. The permissible levels for plutonium are the lowest for any of the radioactive elements. This is occasioned by the concentration of plutonium directly in the blood-forming sections of the bone, rather than the more uniform bone distribution shown by other heavy elements. This increases the possibility of damage from equivalent activities of plutonium and has lead to the adoption of the extremely low permissible levels given.
Radiation Hazard (Section 5): Artificial isotope Pu^{239}, half-life: 2.4×10^4 years; emits alpha particles of 5.15 mev. The permissible levels are: Soluble compounds: In body: 0.04 microcurie; in air: 2×10^{-12} microcurie per milliliter; in water: 1.5×10^{-6} microcurie per milliliter. Insoluble compounds: In body: 0.008 microcurie; in air; 2×10^{-12} microcurie per milliliter.
For further information refer to Atomic Energy Commission, Washington, D. C.

PODOPHYLLIN

Synonym: Podophyllum resin.
Description: Light yellow powder or small, yellow, bulky, fragile lumps; bitter, acrid taste.
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U

Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

POISON IVY

Synonyms: Poison oak; poison sumac.
Description: Leafy plant, vine or bush.
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 2
Acute Systemic: U
Chronic Local: Allergen 2
Chronic Systemic: U
Toxicology: Can cause a dermatitis in susceptible individuals, from bodily contact with the plant, exposure to the smoke from burning plants and contact with material which has been in contact with the plant (Section 9).

POISONOUS LIQUID OR GAS, N.O.S.

Shipping Regulations: Section 11.
I.C.C. Classification: Poison A; poison gas label.
Coast Guard Classification: Poison A; poison gas label.

POISONOUS SOLIDS, N.O.S.

Shipping Regulations: Section 11.
I.C.C. Classification: Poison B, poison label; Poison C, tear gas label.
Coast Guard Classification: Poison B, poison label; Poison C, tear gas label.

POLISHES (METAL, STOVE, FURNITURE), LIQUID

Toxicity: Variable.
Fire Hazard: Dangerous, when exposed to heat or flame; they can react with oxidizing materials (Section 6).
Explosion Hazard: Unknown.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable liquid; red label.
Coast Gurad Classification: Inflammable liquid; red label.

POLISHING COMPOUNDS, LIQUID

See Polishes, Liquid.

Shipping Regulations: Section 11.
Coast Guard Classification: Combustible liquid.

POLONIUM

Description: Radioactive element.
Formula: Po
Constant: At. Wt. 210
Radiation Hazard (Section 5): Natural isotope Po^{210} (Radium F), half-life: 140 days; emits alpha particles of 5.30 mev and gamma rays of 0.77 mev. The permissible levels are: in body: 0.2 microcurie; in air 2×10^{-10} microcurie per milliliter; in water: 3×10^{-5} microcurie per milliliter. Po^{210} is a member of the uranium series (see section on radiation hazard). The permissible levels shown are for soluble polonium compounds where the spleen is the critical organ. For insoluble compounds, the lung is the critical organ and the permissible levels are 7×10^{-11} microcurie per milliliter of air.

Po^{210} is a difficult isotope to handle without contaminating surrounding areas. Extreme care should be taken to contain this material for while the alpha emitters are not important in terms of external radiation, they may become airborne or be ingested very rapidly.

Natural isotope Po^{218} (Radium A), half-life: 3.05 minutes; emits alpha particles of 6.00 mev. Po^{218} is a member of the uranium series (see section on radiation hazard). With its short half-life, it is only considered a hazard as a daughter of Rn^{222} (radon).

POLONIUM CARBONYL

Description: Radioactive material.
Formula: PoCO
Constant: Mol. Wt. 238
Toxicity: Highly toxic. See Carbonyls.
Radiation Hazard: See Polonium.
Fire Hazard: Dangerous, when exposed to heat or by chemical reaction with oxidizing agents (Section 6).
Explosion Hazard: See Carbonyls.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of carbon monoxide; can react vigorously

with oxidizing materials.
Ventilation Control (use high rate): Section 2
Storage and Handling: Section 7

POLONIUM HYDRIDE
Description: Volatile, unstable material.
Formula: PoH_2
Constant:
Mol. Wt. 212.02
Toxicity: Highly toxic. See Hydrides.
Radiation Hazard: See Polonium.
Fire Hazard: Moderate, when exposed to heat.
Explosion Hazard: See Hydrides.
Disaster Control: Dangerous; will react with water or steam to produce flammable gases; can react with oxidizing materials; on contact with acid or acid fumes, it can emit toxic fumes.
Ventilation Control (use high rate): Section 2
Storage and Handling: Section 7

POLONIUM HYDROXIDE
Description: Radioactive solid.
Formula: $Po(OH)_4$
Constant:
Mol. Wt. 278
Radiation Hazard: See Polonium.

POLYAMYL NAPHTHALENE
Description: A mixture of polymers.
Constants:
Flash P. 360°F (O.C.)
Density 0.92 - 0.93
Toxicity: Details unknown. See also Naphthalene.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

POLY-sec-AMYL PHENOL
Constants:
B. P. 305 - 355°C
Flash P. 520°F
Density 0.90 - 0.92 @30°/20°C
Toxicity: Details unknown. See also Phenol.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

POLYCHLOROPENTANES
Constants:
B. P. 174°C
Flash P. 175°F (O.C.)
Density 1.33
Toxicity: See Chlorinated Hydrocarbons (Aliphatic).
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Storage and Handling: Section 7

POLYETHYLENE GLYCOL CHLORIDE 110
Description: Liquid.
Formula: $ClC_2H_4OC_2H_4OH$
Constants:
Mol. Wt. 124.57
M. P. -90°C
B. P. 198.9°C
Flash P. 225°F (O.C.)
Density 1.1753 @20°/20°C
Vap. D. 4.31
Toxicity: See Glycols.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react with oxidizing materials.
Storage and Handling: Section 7

POLYETHYLENE GLYCOLS
Description: Colorless viscous liquids.
Formula: $H(OCH_2CH_2)_nOH$
Constants:
Mol. Wt. 200 - 9000
M. P. -14 to 25°C
Flash P. 360 - 480°F
Density 1.122 - 1.130
Toxicity: See Glycols.
Fire Hazard: Slight, when exposed to heat or flame; they can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon

tetrachloride (Section 6).
Storage and Handling: Section 7

POLYPROPYLENE GLYCOL

Description: Liquid.
Formula: $HO(C_3H_6O)_nH$
Constants:
  Mol. Wt. 400 - 2000
  M. P. Does not crystallize
  Flash P. 390° – > 440°F
  Density 1.002 - 1.007
Toxicity: See Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

POLYVINYL ALCOHOL

Description: Colorless, amorphous powder.
Constants:
  M. P. Decomp. over 200°C
  Flash P. 392°F
  Density 1.329
Toxicity: Details unknown. Polyvinyl alcohol is not considered a toxic hazard. However, technical grades should not be used in foods or drugs without careful testing to assure conformity with the Federal Food, Drug and Cosmetic Act and similar state acts.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Slight, in the form of dust, when exposed to flame.
Personnel Protection: Section 3
Storage and Handling: Section 7

POLYVINYL METHYL ETHER

Description: Light yellow to amber-colored, balsam-like liquid.
Formula: $(C_3H_6O)_x$
Constants:
  Mol. Wt. $(58.1)_x$
  Density 1.05 @25°/4°C
Toxicity: Details unknown. See also Ethers.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Details unknown
  See also Ethers.
Storage and Handling: Section 7

PORTLAND CEMENT

Description: Finely divided gray powder.
Composition: Lime, alumina, silica and iron oxide.
Toxic Hazard Rating:
  Acute Local: Irritant 2; Inhalation 1
  Acute Systemic: 0
  Chronic Local: Irritant 2; Inhalation 1
  Chronic Systemic: 0
MAC: ACGIH (accepted); 50 million particles per cubic foot.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

POTASSIUM

Description: Cubic, silver-metallic crystals.
Formula: K
Constants:
  At. Wt. 39.10
  M. P. 62.3°C
  B. P. 760°C
  Density 0.86 @20°C; 0.83 @62°C
  Vap. Press. 1 mm @341°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Toxicology: The toxicity of potassium compounds is almost always that of the anion.
Radiation Hazard (Section 5): Natural isotope K^{40}, half-life: 1.3×10^9 years; emits beta particles of 1.4 mev and gamma rays of 1.5 mev. K^{40} occurs at the level of about 0.012% in all potassium compounds and therefore cannot be considered as a radiation hazard. Artificial isotope K^{42}, half-life: 12.5 hours; emits beta particles of 3.6 mev (70%) and 1.9 mev (30%) and gamma rays of 1.5 mev. The permissible levels are: In body: 20 microcuries; in air: 2×10^{-6} microcurie per milliliter; in

water: 1×10^{2} microcurie per milliliter. Hazard Rating Class I (National Bureau of Standards Handbook No. 42).

Fire Hazard: Dangerous! Metallic potassium reacts with moisture to form potassium hydroxide and hydrogen. The reaction evolves much heat causing the potassium to melt and spatter. It also ignites the hydrogen which now burns, or if there is any confinement an explosion can occur. Burning potassium is difficult to extinguish; dry powdered soda ash or graphite or special mixtures of dry chemical is recommended. It can ignite spontaneously in moist air (Section 6).

Storage and Handling (Section 7): Store in inert atmospheres, such as argon or nitrogen, or under liquids which are oxygen-free, such as toluene or kerosene, or in glass capsules which have been filled under vacuum or inert atmosphere and sealed before oxygen or moisture can enter. When quantities of this metal are in use, provision should be made for fireproof garments so that personnel can approach close enough to the fire to fight it.

Large quantities of potassium can be disposed of by simply cutting it into small pieces and placing it in an open waste space to react with the moisture in the air and gradually turn to potassium hydroxide. Potassium may be reacted with ethanol to give a stable product. Do not dispose of it, even in small quantities, by throwing it into sinks or waste containers which may contain combustible materials. It should be stored in a detached building which is fireproof and not where it can come in contact with moisture, powerful oxidizing materials or high temperatures.

Do not heat glass vessels which contain metallic potassium to temperatures much in excess of the melting point of potassium, or a vigorous to explosive reaction with the glass can ensue.

Explosion Hazard: Moderate, by chemical reaction. Potassium metal will form the peroxide (K_2O_2) and the superoxide (KO_2 or K_2O_4) at room temperature even when stored under mineral oil. Metal which has oxidized on storage under oil may explode violently when handled or cut. Oxide coated potassium should be destroyed by burning.

Disaster Control: Dangerous; when heated or on contact with acids, it emits highly toxic fumes of oxides of potassium; will react with water or steam to produce heat and hydrogen; can react vigorously with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Shipping Regulations: Section 11.

I. C. C. Classification: Flammable solid; yellow label.

Coast Guard Classification: Inflammable solid; yellow label.

POTASSIUM ACETATE

Description: White powder.

Formula: CH_3COOK

Constants:

Mol. Wt. 98.14

M. P. 292°C

Density 1.8 @20°/20°C

Toxicity: Very low.

Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).

Storage and Handling: Section 7

POTASSIUM ACID FLUORIDE

Description: Cubic, colorless crystals.

Formula: KHF_2

Constants:

Mol. Wt. 78.10

M. P. Decomposes

Toxicity: Highly toxic. See Fluorides.

Disaster Control: Dangerous. See Fluorides.

Storage and Handling: Section 7

POTASSIUM ALUMINUM BORATE, BASIC

Description: Cubic, white crystals.

Formula: $K(AlO)_2(BO_2)_3$

Constants:

Mol. Wt. 253.50

M. P. < 1800°C
Density 3.415
Toxicity: See Boron Compounds and Aluminum Compounds.

POTASSIUM ALUMINUM FLUORIDE

Description: White powder.
Formula: K_3AlF_6
Constant:
Mol. Wt. 258.3
Toxicity: Highly toxic. See Fluorides.
Disaster Control: Dangerous. See Fluorides.
Storage and Handling: Section 7

POTASSIUM AMALGAM

Description: Silvery liquid or solid.
Formula: K + Hg
Toxicity: Highly toxic. See Potassium and Mercury.
Fire Hazard: Moderate, by spontaneous chemical reaction; on contact with moisture hydrogen is liberated. See also Potassium.
Explosion Hazard: Moderate; it liberates hydrogen upon contact with moisture, acids, etc. See also Potassium.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of mercury and oxides of potassium; will react with water, steam or acids to produce hydrogen; can react with oxidizing materials.
Storage and Handling: Section 7

POTASSIUM AMIDE

Synonym: Potassamide.
Description: Colorless-white or yellow-green crystals.
Formula: KNH_2
Constants:
Mol. Wt. 55.12
M. P. 335°C
B. P. Sublimes @400°C
Toxicity: See Ammonia.
Fire Hazard: Moderate, by chemical reaction; can react with moisture to liberate ammonia (Section 6).
Explosion Hazard: Moderate, due to the ammonia liberated.
Disaster Control: Dangerous; will react with water or steam to produce toxic, corrosive and flammable vapors; can react with oxidizing materials.
Storage and Handling: Section 7

POTASSIUM AMMONIUM NITRATE

Synonym: BasF
Description: Gray to light or dark brown crystals.
Formula: $KNO_3 + NH_4NO_3$
Toxicity: Moderate. See Nitrates.
Fire Hazard: Moderate. See Nitrates.
Explosion Hazard: Slight, when shocked or exposed to heat.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

POTASSIUM AMMONIUM SELENOSULFIDE

Description: A solid.
Formula: $(KNH_4S)_5Se$
Constant:
Mol. Wt. 525.01
Toxicity: See Selenium Compounds and Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: Dangerous. See Sulfides and Selenium Compounds.
Storage and Handling: Section 7

POTASSIUM ANTIMONIDE

Description: Yellow-green crystals.
Formula: K_3Sb
Constants:
Mol. Wt. 239.05
M. P. 812°C
Toxicity: Highly toxic. See Antimony Compounds.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Disaster Control: Dangerous; when heated to decomposition or on contact with moisture or acids, it emits highly toxic fumes of antimony; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

POTASSIUM ANTIMONY TARTRATE

Synonym: Tartar emetic.
Description: Rhombic, colorless crystals.

Formula: $KSbC_4H_4O_7 \cdot \frac{1}{2}H_2O$
Constants:
Mol. Wt. 333.94
M. P. $-\frac{1}{2}H_2O$ @100°C
Density 2.607
For other properties, see Potassium Antimonide.

POTASSIUM ARSENATE
Synonyms: Potassium dihydrogen arsenate; Macquer's salt.
Description: Colorless crystals.
Formula: KH_2AsO_4
Constants:
Mol. Wt. 180.02
M. P. 288°C
Density 2.867
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

POTASSIUM ARSENITE
Description: White powder.
Formula: $KAsO_2 \cdot HAsO_2$
Constant:
Mol. Wt. 253.8
For other properties, see Potassium Arsenate.

POTASSIUM AURATE
Description: Light yellow needles.
Formula: $KAuO_2 \cdot 3H_2O$
Constants:
Mol. Wt. 322.34
M. P. Decomposes
Toxicity: See Gold Compounds.

POTASSIUM AZIDE
Description: Colorless crystals.
Formula: KN_3
Constants:
Mol. Wt. 81.12
M. P. 350°C
Density 2.04
Toxicity: See Azides.
Explosion Hazard: Moderate. See Azides.
Disaster Control: Dangerous. See Azides.
Storage and Handling: Section 7

POTASSIUM BERYLLIUM FLUORIDE
Description: White, crystalline masses.
Formula: $BeF_2 \cdot 2KF$
Constant:
Mol. Wt. 163.21
Toxicity: Highly toxic. See Beryllium and Fluorides.

POTASSIUM BERYLLIUM SULFATE
Description: White powder.
Formula: $K_2Be(SO_4)_2$
Constant:
Mol. Wt. 279.4
Toxicity: Highly toxic. See Beryllium.

POTASSIUM BICHROMATE
Synonyms: Potassium dichromate; red potassium chromate.
Description: Bright, yellowish-red, transparent, crystals, bitter, metallic taste.
Formula: $K_2Cr_2O_7$
Constants:
Mol. Wt. 294.21
M. P. 398°C
B. P. Decomp. @500°C
Density 2.69
Toxicity: See Chromium Compounds.
Fire Hazard: Moderate, by chemical reaction. A powerful oxidizer (Section 6).
Storage and Handling: Section 7

POTASSIUM BIFLUORIDE
Synonyms: Potassium acid fluoride; Fremy's salt.
Description: Colorless crystals.
Formula: KHF_2
Constants:
Mol. Wt. 78.10
M. P. Decomposes
Toxicity: Highly toxic. See Fluorides.
Disaster Control: Dangerous. See Fluorides.
Storage and Handling: Section 7

POTASSIUM BINOXALATE
Synonyms: Potassium acid oxalate; salactosella; salt of sorrell; essential salt of lemon.
Description: White, somewhat hygroscopic crystals; bitter, sharp taste.
Formula: KHC_2O_4

Constants:
Mol. Wt. 128.12
M. P. Decomposes
Density 2.0
Toxicity: Highly toxic. See Oxalates.
Fire Hazard: Slight; when heated, it emits toxic fumes.
Storage and Handling: Section 7

POTASSIUM m-BORATE

Description: Colorless crystals.
Formula: KBO_2
Constants:
Mol. Wt. 81.92
M. P. 947 - 950°C
Toxicity: See Boron Compounds.

POTASSIUM BROMATE

Description: White crystals or crystalline powder.
Formula: $KBrO_3$
Constants:
Mol. Wt. 167.01
M. P. 434°C; decomp. @370°C
Density 3.27 @17.5°C
For other properties, see Bromates.
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

POTASSIUM BROMIDE

Description: Cubic, colorless, slightly hygroscopic crystals.
Formula: KBr
Constants:
Mol. Wt. 119.01
M. P. 730°C
B. P. 1380°C
Density 2.75 @25°C
Vap. Press. 1 mm @795°C
For other properties, see Bromides.

POTASSIUM BROMOAURATE

Description: Rhombic, red-brown crystals.
Formula: $KAuBr_4$
Constants:
Mol. Wt. 555.96
M. P. Decomp.
Toxicity: See Gold Compounds.
Disaster Control: See Bromides.
Storage and Handling: Section 7

POTASSIUM BROMOPLATINATE

Description: Cubic, dark red-brown crystals.
Formula: K_2PtBr_6
Constants:
Mol. Wt. 752.92
M. P. Decomp. > 400°C
Density 4.66 @24°C
Toxicity: See Platinum Compounds.
Disaster Control: See Bromides.
Storage and Handling: Section 7

POTASSIUM BROMOPLATINITE

Description: Rhombic, brown crystals.
Formula: K_2PtBr_4
Constant:
Mol. Wt. 593.09
Toxicity: See Platinum Compounds.
Disaster Control: See Bromides.
Storage and Handling: Section 7

POTASSIUM BROMOSTANNATE

Description: Crystals.
Formula: K_2SnBr_6
Constants:
Mol. Wt. 676.39
Density 3.783
Toxicity: See Tin Compounds.
Disaster Control: See Bromides.
Storage and Handling: Section 7

POTASSIUM CACODYLATE

Description: White crystals.
Formula: $K[(CH_3)_2AsO_2] \cdot H_2O$
Constants:
Mol. Wt. 194.09
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: Dangerous. See Arsenic Compounds.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

POTASSIUM CADMIUM IODIDE

Description: White, yellowish crystalline, deliquescent powder.
Formula: $2KI \cdot CdI_2 \cdot 2H_2O$
Constants:
Mol. Wt. 734.31
Density 3.359
Toxicity: Highly toxic. See Cadmium Compounds.
Disaster Control: See Cadmium Compounds.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3

Personal Hygiene: Section 3
Storage and Handling: Section 7

POTASSIUM CARBONYL

Description: Gray-red solid.
Formula: $(KCO)_6$
Constants:
  Mol. Wt. 402.64
  M. P. Explodes
Toxicity: Highly toxic. See Carbonyls.
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Moderate, when shocked, exposed to heat, on contact with water, or by chemical reaction.
Disaster Control: Dangerous; shock will explode it; will react with water or steam to produce heat; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

POTASSIUM CHLORATE

Synonym: Potassium oxymuriate.
Description: Transparent, colorless crystals or white powder; cooling, saline taste.
Formula: $KClO_3$
Constants:
  Mol. Wt. 122.55
  M. P. 368.4°C
  B. P. Decomp. @400°C
  Density 2.32
For other properties, see Chlorates.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  Coast Guard Classification: Oxidizing material; yellow label.

POTASSIUM CHLOROAURATE

Description: Monoclinic, yellow crystals.
Formula: $KAuCl_4$
Constants:
  Mol. Wt. 378.12
  M. P. Decomp. @357°C
Toxicity: See Gold Compounds.
Disaster Control: Dangerous. See Chlorides.

POTASSIUM CHLOROCHROMATE

Synonym: Peligot's salt.
Description: Monoclinic, red crystals.
Formula: $KCrO_3Cl$
Constants: Mol. Wt. 174.56
  M. P. Decomposes
  Density 2.497
Toxicity: See Chromium Compounds.
Fire Hazard: Moderate, by chemical reaction; a powerful oxidizer (Section 6).
Disaster Control: Dangerous. See Chlorides.
Storage and Handling: Section 7

POTASSIUM CHLOROIODATE (III)

Description: Rhombic, yellow crystals.
Formula: $KICl_4$
Constants:
  Mol. Wt. 307.84
  M. P. Decomposes
  Density 1.76 @45°C
Toxicity: Details unknown.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of chlorides and iodides.
Storage and Handling: Section 7

POTASSIUM CHLOROIRIDATE

Description: Cubic, black crystals.
Formula: K_2IrCl_6
Constants:
  Mol. Wt. 484.03
  M. P. Decomposes
  Density 3.546
Toxicity: See Iridium Compounds.
Disaster Control: Dangerous. See Chlorides.
Storage and Handling: Section 7

POTASSIUM CHLOROOSMATE (IV)

Description: Cubic, red crystals.
Formula: K_2OsCl_6
Constants:
  Mol. Wt. 481.1
  M. P. Decomposes
Toxicity: See Osium Compounds.
Disaster Control: Dangerous. See Osmium Compounds and Chlorides.
Storage and Handling: Section 7

POTASSIUM CHLOROPALLADATE

Description: Cubic, red crystals.
Formula: K_2PdCl_6
Constants:
  Mol. Wt. 397.63

M. P. Decomposes
Density 2.738
Toxicity: See Palladium Compounds.
Disaster Control: Dangerous. See Chlorides.
Storage and Handling: Section 7

POTASSIUM CHLOROPLATINATE

Description: Cubic, yellow crystals.
Formula: K_2PtCl_6
Constants:
Mol. Wt. 486.16
M. P. Decomp. @250°C
Density 3.499 @24°C
Toxicity: See Platinum Compounds.
Disaster Control: Dangerous. See Chlorides.
Storage and Handling: Section 7

POTASSIUM* CHLOROPLUMBATE

Description: Cubes.
Formula: K_2PbCl_6
Constants:
Mol. Wt. 498.14
M. P. Decomp. @190°C
Toxicity: Highly toxic. See Lead Compounds.
Disaster Control: Dangerous. See Chlorides and Lead Compounds.
Storage and Handling: Section 7

POTASSIUM CHLORORHENATE (IV)

Description: Yellow-green crystals.
Formula: K_2ReCl_6
Constants:
Mol. Wt. 477.24
Density 3.34
Toxicity: See Rhenium Compounds.
Disaster Control: Moderate. See Chlorides.
Storage and Handling: Section 7

POTASSIUM CHLORORUTHENATE (IV)

Description: Cubic, black crystals.
Formula: K_2RuCl_6
Constants:
Mol. Wt. 392.63
M. P. Decomposes
Toxicity: See Ruthenium Compounds.
Disaster Control: Moderate. See Chlorides.
Storage and Handling: Section 7

POTASSIUM CHLOROSTANNATE

Description: Cubic, colorless crystals.
Formula: K_2SnCl_6
Toxicity: See Tin Compounds.
Disaster Control: See Chlorides.
Storage and Handling: Section 7

POTASSIUM CHLOROTELLURATE

Description: Pale yellow crystals.
Formula: K_2TeCl_6
Constant:
Mol. Wt. 418.54
Toxicity: See Tellurium Compounds.
Disaster Control: Dangerous. See Chlorides.
Storage and Handling: Section 7

POTASSIUM CHROMATE

Synonym: Tarapacaite.
Description: Rhombic, yellow crystals.
Formula: K_2CrO_4
Constants:
Mol. Wt. 194.20
M. P. 968.3°C
Density 2.732 @18°C
Toxicity: See Chromium Compounds.
Fire Hazard: See Chromates.
Storage and Handling: Section 7

POTASSIUM CHROMIC SULFATE

Description: Cubic, red or green crystals.
Formula: $KCr(SO_4)_2 \cdot 12H_2O$
Constants: Mol. Wt. 499.4
M. P. 89°C
B. P. $-12H_2O$ @400°C
Density 1.83
Toxicity: See Chromium Compounds.
Storage and Handling: Section 7

POTASSIUM CHROMIUM CHROMATE, BASIC

Description: Violet-brown, amorphous powder.
Formula: $K_2CrO_4 . 2Cr(OH)CrO_4$
Constants: Mol. Wt. 564.26
M.P. 300°C
Density 2.28 @14°C
Toxicity: See Chromium Compounds.
Fire Hazard: Moderate, by chemical reaction; a powerful oxidizer (Section 6).
Storage and Handling: Section 7

POTASSIUM COBALTINITRITE

Synonym: Fischer's salt.
Description: Yellow prisms.
Formula: $K_3Co(NO_2)_6$
Constant:
Mol. Wt. 452.3

Toxicity: See Cobalt Compounds and Nitrites.
Fire Hazard: Slight, by chemical reaction; an oxidizing agent (Section 6).
Disaster Control: See Nitrites.
Storage and Handling: Section 7

POTASSIUM COBALTOUS SULFATE

Description: Red, monoclinic prisms.
Formula: $K_2SO_4 \cdot CoSO_4 \cdot 6H_2O$
Constants:
Mol. Wt. 437.36
Density 2.218
Toxicity: See Cobalt Compounds.

POTASSIUM COPPER CHLORIDE

Description: Red needles.
Formula: $KCl \cdot CuCl_2$
Constants:
Mol. Wt. 209
Density 2.86
Toxicity: See Copper Compounds.

POTASSIUM CYANATE

Description: Colorless crystals.
Formula: KOCN
Constants: Mol. Wt. 81.11
M. P. 700 - 900°C (decomp.)
Density 2.056 @20°C
Toxicity: Highly toxic. See Cyanides.
Disaster Control: See Cyanates.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

POTASSIUM CYANIDE

Description: White, deliquescent crystalline solid; faint odor of bitter almonds.
Formula: KCN
Constants: Mol. Wt. 65.11
M. P. 634.5°C
Density 1.52 @16°C
Highly toxic. For other properties, see Cyanides.
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

POTASSIUM CYANO-COMPOUNDS

With the exception of the ferri- and ferrocyanides, any compound of potassium containing the cyanogen radical (CN) is highly toxic and should be handled with adequate ventilation and protective equipment. See Cyanides.

POTASSIUM DIBORANE

Synonym: Diboranide.
Description: White crystals.
Formula: $K_2B_2H_6$
Constants:
Mol. Wt. 105.9
B. P. Decomp. @300°C @1 mm
Density 1.18
Toxicity: Details unknown. Probably highly toxic. See also Boron Compounds.

POTASSIUM DIBROMOIODIDE

Description: Rhombic crystals.
Formula: $KIBr_2$
Constants:
Mol. Wt. 325.85
M. P. 60°C
B. P. Decomp. @180°C
Toxicity: See Bromides and Iodides.
Disaster Control: See Bromides and Iodides.
Storage and Handling: Section 7

POTASSIUM DICHLOROIODIDE

Description: Monoclinic crystals.
Formula: $KICl_2$
Constants:
Mol. Wt. 236.93
M. P. 60°C
B. P. Decomp. @215°C
Toxicity: See Chlorides and Iodides.
Fire Hazard: Slight; when heated, it emits toxic fumes of chlorides.
Storage and Handling: Section 7

POTASSIUM DICHROMATE

Description: Red crystals.
Formula: $K_2Cr_2O_7$
Constants: Mol. Wt. 294.2
M. P. 398°C
B. P. Decomp. @500°C
Density 2.69
Toxicity: See Chromium Compounds.
Fire Hazard: Moderate, by chemical reaction; a powerful oxidizer (Section 6).
Storage and Handling: Section 7

POTASSIUM DICYANOGUANIDINE

Description: Crystals.
Formula: NCHNC(NH)NCNK
Constants:
Mol. Wt. 147.2
M. P. Decomp. @265°C
Toxicity: Details unknown. Possibly most toxic by skin absorption.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides.
Storage and Handling: Section 7

POTASSIUM DIFLUOTELLURATE

Description: Crystals.
Formula: $K_2TeO_3F_2 \cdot 3H_2O$
Constants:
Mol. Wt. 345.85
M. P. Decomposes
Toxicity: Highly toxic. See Fluorides.
Disaster Control: Dangerous. See Fluorides.
Storage and Handling: Section 7

POTASSIUM DIGERMANATE

Description: White crystals.
Formula: $K_2Ge_2O_5$
Constants:
Mol. Wt. 303.4
M. P. > 83°C
Density 4.31 @21.5°C
Toxicity: See Germanium Compounds.

POTASSIUM DIHYDROGEN o-ARSENATE

Description: Tetragonal, colorless crystals.
Formula: KH_2AsO_4
Constants:
Mol. Wt. 180
M. P. 288°C
Density 2.867
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: Dangerous. See Arsenic Compounds.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

POTASSIUM DIHYDROXY DIBORANE

Description: Colorless, cubical crystals.
Formula: $K_2B_2H_6O_2$
Constants:
Mol. Wt. 137.88
M. P. Decomposes to K.
Density 1.39
Toxicity: See Boron Compounds.

POTASSIUM DIISOPROPYL DITHIOPHOSPHATE

Description: Colorless, crystalline, nearly odorless solid.
Formula: $[(CH_3)_2CHO]_2PSKS$
Constants:
Mol. Wt. 252.4
M. P. Decomp. near 200°C
Toxicity: Details unknown. Many derivatives of this material are highly toxic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur and phosphorus.
Storage and Handling: Section 7

POTASSIUM DISULFIDE

Description: Red-yellow crystals.
Formula: K_2S_2
Constants:
Mol. Wt. 142.3
M. P. 470°C
Toxicity: See Sulfides.
Disaster Control: Dangerous. See Sulfides.
Storage and Handling: Section 7

POTASSIUM FERRIC SULFIDE

Description: Purple, hexagonal crystals.
Formula: $KFeS_2$
Constants:
Mol. Wt. 159.1
Density 2.563
Toxicity: See Sulfides.
Disaster Control: Dangerous. See Sulfides.
Storage and Handling: Section 7

POTASSIUM FERRICYANIDE

Synonyms: Red prussiate of potash; red potassium prussiate.
Description: Bright red, lustrous crystals or powder.
Formula: $K_3Fe(CN)_6$
Constants:
Mol. Wt. 329.24
M. P. Decomposes
Density 1.894 @17°C

Toxicity: See Ferricyanides. This is not a powerful poison as are the simple cyanides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

POTASSIUM FERROCYANIDE
Synonym: Yellow prussiate of potash.
Description: Lemon yellow crystals.
Formula: $K_4Fe(CN)_6 \cdot 3H_2O$
Constants:
Mol. Wt. 422.39
M. P. $-3H_2O$ @70°C
B. P. Decomposes
Density 1.85 @17°C
Toxicity: Not as toxic as the simple cyanides. See Ferrocyanides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides.
Storage and Handling: Section 7

POTASSIUM FLUOBERYLLATE
Description: Rhombic, colorless crystals.
Formula: K_2BeF_4
Constants:
Mol. Wt. 163.2
M. P. Red heat
Toxicity: Highly toxic. See Beryllium and Fluorides.
Disaster Control: Dangerous. See Fluorides.
Ventilation Control (use high rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

POTASSIUM FLUOBORATE
Synonym: Avogadrite.
Description: Rhombic or cubic, colorless crystals.
Formula: KBF_4
Constants:
Mol. Wt. 125.9
M. P. 530°C
Density 2.498
Toxicity: See Fluorides and Boron Compounds.
Disaster Control: Dangerous. See Fluorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

POTASSIUM FLUOGERMANATE
Description: Hexagonal, white crystals.
Formula: K_2GeF_6
Constants:
Mol. Wt. 264.8
M. P. 730°C
B. P. Approx. 835°C
Toxicity: See Fluorides.
Disaster Control: Dangerous. See Fluorides.

POTASSIUM FLUORIDE
Description: White, crystalline, deliquescent powder; sharp, saline taste.
Formula: KF
Constants:
Mol. Wt. 58.1
M. P. 880°C
B. P. 1500°C
Density 2.48
Vap. Press. 1 mm @885°C
Toxicity: Highly toxic. See Fluorides.
Disaster Control: Dangerous. See Fluorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

POTASSIUM FLUOSILICATE
Synonym: Hieratite.
Description: Hexagonal or cubic, colorless crystals.
Formula: K_2SiF_6
Constants:
Mol. Wt. 220.25
M. P. Decomposes
Density Hex.: 3.08; Cubic: 2.665 @17°C
For other properties, see Fluosilicates.

POTASSIUM FLUOSTANNATE
Description: Monoclinic prisms.

Formula: $K_2SnF_6 \cdot H_2O$
Constants:
Mol. Wt. 328.9
Density 3.058
For other properties, see Fluorides.

POTASSIUM FLUOSULFONATE

Description: Short, thick prisms.
Formula: $KFSO_3$
Constants:
Mol. Wt. 138.16
M. P. 311°C
For other properties, see Fluorides.

POTASSIUM FLUOTANTALATE

Description: Rhombic, colorless crystals.
Formula: K_2TaF_7
Constants:
Mol. Wt. 392.1
Density 4.56; 5.24
For other properties, see Fluorides.
Disaster Control: Dangerous. See Fluorides.
Storage and Handling: Section 7

POTASSIUM FLUOTHORATE

Description: Colorless crystals.
Formula: $K_2ThF_6 \cdot 4H_2O$
Constant:
Mol. Wt. 496.38
For other properties, see Fluorides.

POTASSIUM FLUOTITANATE

Description: Colorless, small, lustrous leaflets.
Formula: $K_2TiF_6 \cdot H_2O$
Constants:
Mol. Wt. 258.1
M. P. 780°C
B. P. Decomposes
For other properties, see Fluorides.

POTASSIUM FLUOZIRCONATE

Description: Monoclinic, colorless crystals.
Formula: K_2ZrF_6
Constants:
Mol. Wt. 283.4
Density 3.48
For other properties, see Fluorides.

POTASSIUM FORMATE

Description: Colorless, deliquescent crystals.
Formula: HCOOK
Constants:
Mol. Wt. 84.1
M. P. 168°C
B. P. Decomposes
Density 1.91
Toxicity: See Formic Acid and Potassium Compounds.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

POTASSIUM GALLIUM SULFATE

Description: Colorless crystals.
Formula: $KGa(SO_4)_2 \cdot 12H_2O$
Constants:
Mol. Wt. 517.14
Density 1.895
Toxicity: See Gallium Compounds.

POTASSIUM m-GERMANATE

Description: White crystals.
Formula: K_2GeO_3
Constants:
Mol. Wt. 198.79
M. P. 823°C
Density 3.40 @21.5°C
Toxicity: See Germanium Compounds.

POTASSIUM HEXAFLUOROPHOSPHATE

Synonym: FP Salt No. 4.
Formula: KPF_6
Constants:
Formula Wt. 184.1
M. P. About 575°C
B. P. Decomposes
Density 2.59
Toxicity: Probably very low.
Disaster Control: Dangerous; when heated to decomposition, or on contact with acid or acid fumes, it emits highly toxic fumes of fluorides and oxides of phosphorus.
Storage and Handling: Section 7

POTASSIUM HYDRIDE

Description: White needles.
Formula: KH
Constants:
Mol. Wt. 40.1
M. P. Decomposes
Density 1.43 - 1.47
Toxicity: See Potassium and Hydrides.
Fire Hazard: Dangerous, by chemical reaction (See Potassium).
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to heat or by spontaneous

chemical reaction.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of potassium oxide; will react with water, steam or acids to produce hydrogen; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

POTASSIUM HYDROGEN OXALATE

Description: Monoclinic, colorless crystals.
Formula: KHC_2O_4
Constants:
Mol. Wt. 128.1
M. P. Decomposes
Density 2.0
Toxicity: Highly toxic. See Oxalates.

POTASSIUM HYDROGEN SULFITE

Synonym: Potassium bisulfite.
Description: Colorless crystals.
Formula: $KHSO_3$
Constants:
Mol. Wt. 120.17
M. P. Decomp. @190°C
Toxicity: See Sulfites.
Disaster Control: See Sulfites.

POTASSIUM HYDROSULFIDE

Synonym: Potassium bisulfide, potassium sulphydrate.
Description: Rhombic, yellow, deliquescent crystals (commercial).
Formula: KHS
Constants: Mol. Wt. 72.17
M. P. 455°C
Density 2.0
For other properties, see Sulfides.

POTASSIUM HYDROXIDE

Synonym: Potassium hydrate.
Description: White, deliquescent pieces, lumps or sticks having crystalline fracture.
Formula: KOH
Constants:
Mol. Wt. 56.11
M. P. 360°C ± 7°C
B. P. 1320°C
Density 2.044
Vap. Press. 1 mm @719°C
Toxicity: Highly caustic. See Potassium.
Fire Hazard: Moderate.
Disaster Control: Dangerous; will react with water or steam to produce caustic solution and heat.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Hazardous article.
I. C. C. Classification: Solution: Corrosive liquid; white label.
MCA warning label.

POTASSIUM HYDROXOANTIMONATE

Synonym: Pyroantimonate.
Description: Granular, white, crystalline powder.
Formula: $KSb(OH)_6 \cdot {}^1/_2H_2O$
Constant:
Mol. Wt. 271.9
Toxicity: Highly toxic. See Antimony Compounds.
Disaster Control: See Antimony Compounds.

POTASSIUM HYDROXOPLATINATE

Description: Rhombic, yellow crystals.
Formula: $K_2Pt(OH)_6$
Constants:
Mol. Wt. 375.47
M. P. Decomposes
Toxicity: See Platinum Compounds.

POTASSIUM HYDROXOPLUMBATE

Description: Colorless crystals.
Formula: $K_2Pb(OH)_6$
Constant:
Mol. Wt. 387.45
Toxicity: See Lead Compounds.
Disaster Control: See Lead Compounds.

POTASSIUM HYDROXOSTANNATE

Description: Colorless crystals.
Formula: $K_2Sn(OH)_6$
Constants:
Mol. Wt. 298.94
Density 3.197
Toxicity: See Tin Compounds.

POTASSIUM HYPOCHLORITE
Description: Solution only.
Formula: $KClO$
Constants:
Mol. Wt. 90.55
M. P. Decomposes
Toxicity: See Hypochlorites.
Disaster Control: See Hypochlorites.
Storage and Handling: Section 7

POTASSIUM HYPONITRITE
Toxicity: See Nitrites.
Fire Hazard: See Nitrites.
Explosion Hazard: Moderate, when exposed to heat.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react with reducing materials.
Storage and Handling: Section 7

POTASSIUM HYPOPHOSPHITE
Description: White, opaque, very deliquescent crystals or powder; pungent saline taste.
Formula: KH_2PO_2
Constants:
Mol. Wt. 104.09
M. P. Decomposes
For other properties, see Hypophosphites.

POTASSIUM IODATE
Description: Colorless crystals.
Formula: KIO_3
Constants:
Mol. Wt. 214
M. P. 560°C
Density 3.89
For other properties, see Iodates.

POTASSIUM IODIDE
Description: Colorless or white granules.
Formula: KI
Constants:
Mol. Wt. 166.02
M. P. 723°C
B. P. 1420°C
Density 3.13
Vap. Press. 1 mm @745°C
Toxicity: See Iodides.

POTASSIUM IODOAURATE
Description: Lustrous, black crystals.
Formula: $KAuI_4$
Constant:
Mol. Wt. 743.98
Toxicity: See Gold Compounds and Iodides.
Disaster Control: See Iodides.

POTASSIUM IODOIRIDITE
Description: Green crystals.
Formula: K_3IrI_6
Constants:
Mol. Wt. 1071.9
M. P. Decomposes
Toxicity: See Iridium Compounds and Iodides.

POTASSIUM IODOMERCURATE (II)
Synonym: Potassium mercury iodide.
Description: Yellow, deliquescent prisms.
Formula: $KHgI_3$
Constant:
Mol. Wt. 620.47
Toxicity: Highly toxic. See Mercury Compounds.

POTASSIUM IODOPLATINATE
Description: Black crystals.
Formula: K_2PtI_6
Constants:
Mol. Wt. 1034.94
Density 5.176
Toxicity: See Platinum Compounds.
Disaster Control: See Iodides.

POTASSIUM LEAD CHLORIDE
Synonym: Pseudo cotunnite.
Description: Yellow crystals.
Formula: $2KCl \cdot PbCl_2$
Constants:
Mol. Wt. 427.23
M. P. 490°C
Toxicity: Highly toxic. See Lead Compounds.
Disaster Control: See Chlorides.

POTASSIUM MAGNESIUM CHROMATE
Description: Triclinic crystals.
Formula: $K_2CrO_4 \cdot MgCrO_4 \cdot 2H_2O$
Constants:
Mol. Wt. 370.56
Density 2.59
Toxicity: See Chromium Compounds.
Fire Hazard: Moderate, by chemical reaction; a powerful oxidizer (Section 6).
Disaster Control: Dangerous. Keep away from combustible materials.
Storage and Handling: Section 7

POTASSIUM MANGANATE

Description: Rhombic, green crystals.
Formula: K_2MnO_4
Constants:
  Mol. Wt. 197.12
  M. P. Decomp. @190°C
Toxicity: See Manganese Compounds.
Fire Hazard: Moderate, by chemical reaction; a powerful oxidizer (Section 6).
Disaster Control: Dangerous. Keep away from combustible materials.
Storage and Handling: Section 7

POTASSIUM MANGANIC SULFATE

Description: Violet crystals.
Formula: $KMn(SO_4)_2 \cdot 12H_2O$
Constant:
  Mol. Wt. 502.35
Toxicity: See Manganese Compounds.

POTASSIUM MANGANICYANIDE

Description: Rhombic, red crystals.
Formula: $K_2Mn(CN)_6$
Constant:
  Mol. Wt. 328.33
Toxicity: Highly toxic. See Cyanides and Magnesium Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

POTASSIUM MANGANOCYANIDE

Description: Deep blue crystals.
Formula: $K_4Mn(CN)_6 \cdot 3H_2O$
Constant:
  Mol. Wt. 421.47
Toxicity: Highly toxic. See Cyanides and Magnesium Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

POTASSIUM MANGANOUS CHLORIDE

Synonym: Chloromanganokalite.
Description: Crystals.
Formula: $4KCl \cdot MnCl_2$
Constants:
  Mol. Wt. 424.06
  Density 2.31
Toxicity: See Manganese Compounds.
Disaster Control: Moderate. See also Chlorides.

POTASSIUM MANGANOUS SULFATE

Synonym: Manganolangbeinite.
Description: Rose-red crystals.
Formula: $K_2SO_4 \cdot 2MnSO_4$
Constants:
  Mol. Wt. 476.23
  M. P. 850°C
  Density 3.02
Toxicity: See Manganese Compounds.

POTASSIUM MERCURICYANIDE

Description: Colorless crystals.
Formula: $K_2Hg(CN)_4$
Constant: Mol. Wt. 382.87
Toxicity: Highly toxic. See Cyanides and Mercury Compounds, Organic.
Disaster Control: Dangerous. See Mercury Compounds, Organic and Cyanides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

POTASSIUM MERCUROUS TARTRATE

Description: White, crystalline powder.
Formula: $KHgC_4H_4O_6$
Constant:
  Mol. Wt. 387.78
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: Dangerous. See Mercury Compounds, Organic.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

POTASSIUM, METALLIC, LIQUID ALLOY. See Potassium.
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid; yellow label.

POTASSIUM METHAZONATE
Toxicity: Unknown
Fire Hazard: Unknown
Explosion Hazard: Severe, when shocked or exposed to heat.
Disaster Control: Dangerous; shock will explode it; when heated to decomposition, it emits highly toxic fumes of potassium.
Storage and Handling: Section 7

POTASSIUM METHYL SULFATE
Description: White crystals.
Formula: $2KCH_3SO_4 \cdot H_2O$
Constant:
  Mol. Wt. 318.41
Toxicity: Details unknown. Probably highly toxic. See also Dimethyl Sulfate.
Fire Hazard: Moderate, when exposed to heat or flame; it decomposes readily to flammable products (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

POTASSIUM MONOHYDROGEN o-ARSENATE
Description: Colorless crystals.
Formula: K_2HAsO_4
Constant:
  Mol. Wt. 218.11
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: Dangerous. See Arsenic Compounds.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

POTASSIUM MONOSULFIDE
Description: Yellow-brown, deliquescent crystals.
Formula: K_2S
Constants:
  Mol. Wt. 110.26
  M. P. 840°C
  Density 1.805 @14°C
For other properties, see Sulfides.

POTASSIUM MONOXIDE
Description: Cubic colorless-gray crystals.
Formula: K_2O
Constants:
  Mol. Wt. 94.19
  Density 2.32 @0°C
Toxicity: See Potassium.
Fire Hazard: Moderate, by chemical reaction; will react with water or steam to produce heat (Section 6).
Storage and Handling: Section 7

POTASSIUM NICKEL SULFATE
Description: Blue crystals.
Formula: $K_2SO_4 \cdot NiSO_4 \cdot 6H_2O$
Constants:
  Mol. Wt. 437.11
  M. P. Decomp. < 100°C
  Density 2.124
Toxicity: See Nickel Compounds.

POTASSIUM NITRATE
Synonyms: Niter; nitre; saltpeter.
Description: Transparent, colorless or white, crystalline powder or crystals; cooling, pungent, saline taste.
Formula: KNO_3
Constants:
  Mol. Wt. 101.10
  M. P. 334°C
  B. P. Decomp. @400°C
  Density 2.109 @16°C
Toxicity: See Nitrates.
Fire Hazard: Moderate; an oxidizing material. See Nitrates.
Disaster Control: Dangerous. See Nitrates.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Oxidizing material; yellow label.
  Coast Guard Classification: Oxidizing material.

POTASSIUM NITRATE MIXED (FUSED) WITH SODIUM NITRITE. See Potassium Nitrate and Sodium Nitrite.

Shipping Regulations: Section 11.
  I. C. C. Classification: Oxidizing material.
  Coast Guard Classification: Oxidizing material.

POTASSIUM NITRIDE

Description: Greenish-black crystals.
Formula: K_3N
Constants:
  Mol. Wt. 131.30
  M. P. Decomposes
Toxicity: Details unknown. See Ammonia which is readily evolved on contact with moisture.
Fire Hazard: Moderate. See Ammonia.
Explosion Hazard: Moderate. See Ammonia.
Disaster Control: Dangerous; when heated to decomposition or on contact with moisture, acid or acid fumes, it can emit toxic fumes.
Storage and Handling: Section 7

POTASSIUM NITRITE

Description: White or slightly yellowish, deliquescent prisms or sticks.
Formula: KNO_2
Constants:
  Mol. Wt. 85.10
  M. P. 387°C
  B. P. Decomposes
  Density 1.915
Toxicity: See Nitrites.
Fire Hazard: Moderate; an oxidizing material. See Nitrites.
Explosion Hazard: Slight, when exposed to heat. It will explode at 1000°F or when mixed with cyanide salts and heated.
Disaster Control: Dangerous. See Nitrites.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Oxidizing material; yellow label.
  Coast Guard Classification: Oxidizing material; yellow label.

POTASSIUM NITROCYANIDE

Description: A solid.
Constant:
  M. P. Explodes @752°F
Toxicity: Highly toxic. See Cyanides.
Fire Hazard: Unknown
Explosion Hazard: Moderate; it will explode at 752°F.
Disaster Control: Dangerous; on decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

POTASSIUM NITROMETHANE

Toxicity: See Nitroparaffins.
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Severe, when shocked or exposed to heat.
Disaster Control: Dangerous; shock will explode it; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

POTASSIUM m-NITROPHENOXIDE

Description: Flat, orange needles.
Formula: $KOC_6H_4NO_2 \cdot 2H_2O$
Constants:
  Mol. Wt. 213.23
  M. P. $-2H_2O$ @130°C
  B. P. Decomposes
  Density 1.691 @20°C
Toxicity: Highly toxic. See Phenol.
Disaster Control: Dangerous; when heated to decomposition or on contact with acids of acid fumes, it emits highly toxic fumes of oxides of nitrogen.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

POTASSIUM NITROPLATINATE

Description: Monoclinic, colorless crystals.
Formula: $K_2Pt(NO_2)_4$
Constants:
  Mol. Wt. 457.45
  M. P. Decomposes
Toxicity: See Platinum Compounds and Nitrates.
Fire Hazard: See Nitrates.

Disaster Control: See Nitrates.
Storage and Handling: Section 7

POTASSIUM NITROPRUSSIDE

Description: Red, hygroscopic crystals.
Formula: $K_2[Fe(NO)(CN)_5] \cdot 2H_2O$
Constant:
Mol. Wt. 330.17
Toxicity: Highly toxic. See Cyanides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acids or acid fumes, it emits highly toxic fumes of cyanides and oxides of nitrogen.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

POTASSIUM OSMATE

Synonym: Potassium perosmate.
Description: Violet, hygroscopic crystals.
Formula: $K_2OsO_4 \cdot 2H_2O$
Constants:
Mol. Wt. 368.42
M. P. $-H_2O$ above 100°C
Toxicity: See Osmium Compounds.
Fire Hazard: Moderate, by chemical reaction; a powerful oxidizer (Section 6).
Storage and Handling: Section 7

POTASSIUM OXALATE

Description: Colorless, transparent crystals.
Formula: $K_2C_2O_4 \cdot H_2O$
Constants:
Mol. Wt. 184.23
M. P. Decomposes
Density 2.127 @39°C
Toxicity: Highly toxic. See Oxalates.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

POTASSIUM OXALATOURANATE (IV)

Description: Yellow crystals.
Formula: $K_4[U(C_2O_4)_4] \cdot 5H_2O$
Constants: Mol. Wt. 836.61
Density 2.563
Toxicity: Highly toxic. See Oxalates.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3

POTASSIUM OXYBORATE

Description: White crystals.
Formula: $KBO_3 \cdot {}^1/_2H_2O$
Constant: Mol. Wt. 106.92
Toxicity: See Boron Compounds.

POTASSIUM PENTABORANE

Synonym: Pentaboranide.
Description: White powder.
Formula: $K_2B_5H_9$
Constants: Mol. Wt. 141.36
M. P. Decomp. < 180°C
Toxicity: Probably highly toxic. See Boron Hydrides.

POTASSIUM PENTABORATE

Description: Colorless crystals; fine granular structure.
Formula: $KB_5O_8 \cdot 4H_2O$
Constants: Mol. Wt. 449.66
M. P. 780°C
Toxicity: See Boron Compounds.

POTASSIUM PENTACHLOROAQUORUTHENATE (III)

Description: Rose prisms.
Formula: $K_2Ru(H_2O)Cl_5$
Constants:
Mol. Wt. 375.19
M. P. $-H_2O$ @200°C
Toxicity: Probably slight. See Ruthenium Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of chlorides.
Storage and Handling: Section 7

POTASSIUM PENTACHLOROHYDROXO RUTHENATE (IV)

Description: Brown-red crystals.
Formula: $K_2Ru(OH)Cl_5$
Constants:
Mol. Wt. 374.19
M. P. Decomposes
Toxicity: Probably slight. See Ruthenium Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of chlorides.
Storage and Handling: Section 7

POTASSIUM PENTACHLORONITROSYL RUTHENATE (III)

Description: Rhombic, dark red

crystals.
Formula: $K_2Ru(NO)Cl_5$
Constants:
Mol. Wt. 387.19
M. P. Decomposes
Toxicity: Probably slight. See Ruthenium Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

POTASSIUM PENTACHLORO-RHODITE

Description: Rhombic, red crystals.
Formula: K_2RHCl_5
Constants:
Mol. Wt. 358.39
M. P. Decomposes
Toxicity: Probably slight. See Rhodium Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

POTASSIUM PENTAFLUONIOBATE

Synonym: Potassium oxyniobate.
Description: Monoclinic, colorless leaflets.
Formula: $K_2NbOF_5 \cdot H_2O$
Constant:
Mol. Wt. 300.12
Toxicity: Probably toxic. See Fluorides.
Disaster Control: Dangerous. See Fluorides.
Storage and Handling: Section 7

POTASSIUM PENTASULFIDE

Description: Orange crystals.
Formula: K_2S_5
Constants:
Mol. Wt. 238.52
M. P. 206°C
For other properties, see Sulfides.

POTASSIUM PERCHLORATE

Synonym: Potassium hyperchlorate.
Description: Colorless crystals or white, crystalline powder.
Formula: $KClO_4$
Constants:
Mol. Wt. 138.55
M. P. 610° ± 10°C
Density 2.52 @10°C
For other properties, see Perchlorates.
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

POTASSIUM m-PERIODATE

Description: Tetragonal, colorless crystals.
Formula: KIO_4
Constants:
Mol. Wt. 230.0
M. P. 582°C
B. P. -O @300°C
Density 3.618 @15°C
Toxicity: Probably toxic. See Iodates.
Fire Hazard: An oxidizing agent and moderate fire hazard. See Iodates.
Explosion Hazard: Slight, when exposed to heat. Explodes @1076°F.
Disaster Control: Dangerous, when exposed to heat or flame; on decomposition it emits toxic fumes of iodine compounds.
Storage and Handling: Section 7

POTASSIUM PERMANGANATE

Description: Dark purple crystals with a blue metallic sheen; sweetish astringent taste.
Formula: $KMnO_4$
Constants:
Mol. Wt. 158.03
M. P. Decomp. below 240°C
Density 2.703
Toxicity: See Manganese Compounds.
Fire Hazard: Moderate, by chemical reaction. A powerful oxidizing agent. Spontaneously flammable on contact with glycerine and ethylene glycol. See also Permanganates.
Disaster Control: Dangerous; keep away from combustible materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Oxidizing material; yellow label.

POTASSIUM PEROXIDE

Description: Yellow, amorphous mass (white crystals).

Formula: K_2O_2
Constants:
  Mol. Wt. 110.19
  M. P. 490°C
Toxicity: See Peroxides, Inorganic.
Fire Hazard: Dangerous, by spontaneous chemical reaction. It is a very powerful oxidizer. Fires of this material should be handled like sodium peroxide.
Explosion Hazard: Moderate, by spontaneous chemical reaction.
Disaster Control: Dangerous; will react with water or steam to produce heat; on contact with reducing material, it can react vigorously, and on contact with acid or acid fumes, it can emit toxic fumes.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Oxidizing material; yellow label.
  Coast Guard Classification: Oxidizing material; yellow label.

POTASSIUM PEROXYCHROMATE
Description: Brown-red crystals.
Formula: K_3CrO_8
Constants:
  Mol. Wt. 297.3
  M. P. Decomp. @170°C
Toxicity: Highly toxic. See Chromium Compounds.
Fire Hazard: Moderate, by chemical reaction; a powerful oxidizer (Section 6).
Disaster Control: Dangerous; keep away from combustible materials.
Storage and Handling: Section 7

POTASSIUM PERRHENATE
Description: White crystals.
Formula: $KReO_4$
Constants:
  Mol. Wt. 289.41
  M. P. 350°C
  Density 4.887
Toxicity: See Rhenium Compounds.
Fire Hazard: Moderate, by chemical reaction; a powerful oxidizier (Section 6).
Disaster Control: Dangerous. Keep away from combustible materials.
Storage and Handling: Section 7

POTASSIUM PERRUTHENATE
Description: Black crystals.
Formula: $KRuO_4$
Constants:
  Mol. Wt. 204.8
  M. P. Decomp. @440°C
Toxicity: Probably slight. See Ruthenium Compounds.
Fire Hazard: Moderate, by chemical reaction; a powerful oxidizer (Section 6).
Disaster Control: Dangerous. Keep away from combustible materials.
Storage and Handling: Section 7

POTASSIUM PERSELENATE
Description: Crystals.
Formula: $KSeO_4$
Constant:
  Mol. Wt. 182.1
Toxicity: Highly toxic. See Selenium Compounds.
Fire Hazard: Moderate, by chemical reaction; a powerful oxidizer (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of selenium; keep away from combustible materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

POTASSIUM PERSULFATE
Synonym: Anthion; potassium peroxydisulfate.
Description: White odorless crystals.
Formula: $K_2S_2O_8$
Constants:
  Mol. Wt. 270.3
  M. P. Decomposes below 100°C
  Density 2.477
Toxic Hazard Rating:
  Acute Local: Irritant 2; Allergen 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: Irritant 1; Allergen 2
  Chronic Systemic: Ingestion 1; Inhalation 1
Fire Hazard: Moderate, when exposed to heat or by chemical reaction. It liberates oxygen @ 212°F when dry, or at room temperature when in solution (Section 6).
Disaster Control: Dangerous; when

heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react with reducing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

POTASSIUM PHENOL SULFONATE

Description: Rhombic crystals.
Formula: $KC_6H_4(OH)SO_3$
Constants:
Mol. Wt. 212.26
M. P. > 260 °C
Density 1.87
Toxicity: Highly toxic. See Phenol.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

POTASSIUM PHENYLACETATE

Description: Dry powder.
Formula: $C_6H_5CH_2COOK$
Constant:
Mol. Wt. 174.2
Toxicity: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

POTASSIUM PHENYL SULFATE

Description: Rhombic leaflets.
Formula: $KC_6H_5SO_4$
Constants:
Mol. Wt. 212.26
M. P. 150 - 160 °C Decomposes
B. P. Decomposes
Toxicity: Highly toxic. See Phenol.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

POTASSIUM PHTHALIMIDE

Description: White powder.
Formula: $C_6H_4(CO)_2NK$
Constant:
Mol. Wt. 185.23
Toxicity: Details unknown; an insecticide.
Fire Hazard: Slight; when heated, it emits toxic fumes (Section 6).
Storage and Handling: Section 7

POTASSIUM PICRATE

Description: Yellow-reddish or greenish crystals.
Formula: $KC_6H_2N_3O_7$
Constants: Mol. Wt. 267.20
B. P. Explodes @ 310 °C
Density 1.852
Toxicity: Highly toxic. See Picric Acid.
Fire Hazard: See Nitrates.
Explosion Hazard: Moderate, when shocked or exposed to heat.
Explosive Range: @ 310 °C
Disaster Control: Dangerous; shock will explode it; on decomposition, it emits highly toxic fumes of oxides of nitrogen; can react vigorously with reducing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

POTASSIUM POLYSULFIDES. See Sulfides.

POTASSIUM PYROSULFITE

Synonym: Potassium metabisulfite.
Description: Monoclinic plates.
Formula: $K_2S_2O_5$
Constants:
Mol. Wt. 222.32
M. P. Decomposes
Density 2.3
For other properties, see Sulfites.

POTASSIUM RHODIUM SULFATE

Description: Yellow cubes.
Formula: $KRh(SO_4)_3 \cdot 12H_2O$
Constants: Mol. Wt. 550.33
Density 2.23
Toxicity: See Rhodium Compounds.

POTASSIUM RUTHENATE

Description: Black crystals.

Formula: $K_2RuO_4 \cdot H_2O$
Constants:
Mol. Wt. 261.91
M. P. $-H_2O$ @200°C
B. P. Decomp. 400°C vac.
Toxicity: See Ruthenium Compounds.

POTASSIUM SELENATE

Description: Rhombic, colorless crystals.
Formula: K_2SeO_4
Constants:
Mol. Wt. 221.15
Density 3.066
For other properties, see Selenium Compounds.

POTASSIUM SELENIDE

Description: White crystals; reddens on exposure to air.
Formula: K_2Se
Constants:
Mol. Wt. 157.15
Density 2.851 @15°C
For other properties, see Selenium Compounds.

POTASSIUM SELENITE

Description: White, deliquescent crystals.
Formula: K_2SeO_3
Constant:
Mol. Wt. 205.15
For other properties, see Selenium Compounds.

POTASSIUM SELENOCYANATE

Description: Deliquescent needles.
Formula: KSeCN
Constants:
Mol. Wt. 144.1
M. P. Decomp. @100°C
Density 2.347
Toxicity: Highly toxic. See Selenium Compounds and Cyanates.
Disaster Control: Dangerous. See Selenium Compounds and Cyanates.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

POTASSIUM SELENOCYANOPLATINATE

Description: Rhombic crystals.
Formula: $K_2Pt(SeCN)_6$
Constants:
Mol. Wt. 903.29
M. P. Decomp. @80°C
Density 3.378 @12.5°C
Toxicity: Highly toxic. For other properties see Potassium Selenocyanate.

POTASSIUM SILICOFLUORIDE

Description: White, odorless, fine crystalline powder.
Formula: K_2SiF_6
Constants: Mol. Wt. 220.25
Density 2.27
For other properties, see Fluosilicates.

POTASSIUM SILVER CARBONATE

Description: Rectangular plates.
Formula: $KAgCO_3$
Constants:
Mol. Wt. 206.99
M. P. Decomp.
Density 3.769
Toxicity: See Silver Compounds.

POTASSIUM SILVER NITRATE

Description: Monoclinic crystals.
Formula:
$KNO_3 \cdot AgNO_3$
Constants:
Mol. Wt. 270.99
M. P. 125°C
Density 3.219
For other properties, see Nitrates.

POTASSIUM SODIUM ANTIMONY TARTRATE

Description: White scales or powder.
Formula: $KNaSbC_4H_3O_7$
Constant:
Mol. Wt. 346.9
Toxicity: Highly toxic. See Antimony Compounds.

POTASSIUM STRONTIUM CHROMIC OXALATE

Description: Greenish-black crystals.
Formula: $KSrCr(C_2O_4)_3 \cdot 6H_2O$
Constants:
Mol. Wt. 550.89
Density 2.155 @13°C
Toxicity: Highly toxic. See Oxalates.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1

POTASSIUM STYPHNATE
Synonym: Potassium trinitroresorcinate.
Description: Yellow, monoclinic prisms.
Formula: $KC_6H_2N_3O_8 \cdot H_2O$
Constants:
  Mol. Wt. 301.21
  M. P. $-H_2O$ @120°C
  B. P. Explodes
For other properties, see Nitrates and Explosives, High.

POTASSIUM SULFHYDRATE
Synonym: Potassium hydrosulfide, potassium bisulfide.
Description: Colorless, hygroscopic crystals.
Formula: KHS
Constants: Mol. Wt. 72.17
  M. P. 455°C
  Density 2.0
For other properties, see Sulfides.

POTASSIUM SULFIDE
Synonyms: Potassium sulfuret, hepar sulfuris.
Description: Red, crystalline mass; deliquescent in air.
Formula: K_2S
Constants:
  Mol. Wt. 110.25
  M. P. 471°C
  Density 1.805 @14°C
For other properties, see Sulfides.
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid; yellow label.

POTASSIUM SULFITE
Description: White-yellowish crystals.
Formula: $K_2SO_3 \cdot 2H_2O$
Constants:
  Mol. Wt. 194.29
  M. P. Decomp.
Toxicity: See Sulfites.
Disaster Control: See Sulfites.

POTASSIUM SULFOCARBONATE
Synonym: Potassium thiocarbonate.
Description: Yellowish-red crystals.
Formula: K_2CS_3
Constants: Mol. Wt. 186.4
  M. P. Decomp.
Toxicity: Details unknown; a soil fumigant.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

POTASSIUM SULFOCYANATE
Synonyms: Potassium rhodanide, potassium thiocyanate.
Description: Colorless crystals.
Formula: $KSCN$
Constants:
  Mol. Wt. 97.17
  M. P. 173.2°C
  Density 1.886
  B. P. Decomp. @500°C
Toxicity: Highly toxic. See Cyanates.
Disaster Control: Dangerous; on decomposition it emits highly toxic fumes of cyanides.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

POTASSIUM SUPEROXIDE
Description: Yellow leaflets.
Formula: KO_2
Constants:
  Mol. Wt. 71.10
  M. P. Approx. 400°C
  B. P. Decomp.
Toxicity: See Peroxides, Inorganic.
Fire Hazard: Dangerous; a powerful oxidizing agent.
Explosion Hazard: Unknown.
Disaster Control: Dangerous; reacts with water or steam to evolve heat; keep away from combustible materials.
Storage and Handling: Section 7

POTASSIUM TELLURATE
Description: Soft, glutinous mass.
Formula: K_2TeO_4
Constants:
  Mol. Wt. 269.80
  M. P. Decomp. @200°C
For other properties, see Tellurium Compounds.

POTASSIUM TELLURIDE
Description: Colorless crystals.
Formula: K_2Te
Constants:
  Mol. Wt. 205.80
  Density 2.51
For other properties, see Tellurium Compounds.

POTASSIUM TELLURITE
Description: White, deliquescent crystals.
Formula: K_2TeO_3
Constants:
Mol. Wt. 253.80
M. P. 460 - 470°C decomp.
For other properties, see Tellurium Compounds.

POTASSIUM TETRABORATE
Description: Colorless crystals.
Formula: $K_2B_4O_7 \cdot 8H_2O$
Constants:
Mol. Wt. 377.60
M. P. Decomp.
Density Anhydrous: 1.74
For other properties, see Boron Compounds.

POTASSIUM TETRAGERMANATE
Description: White crystals.
Formula: $K_2Ge_4O_9$
Constants:
Mol. Wt. 512.59
M. P. 1033°C
Density 4.12 @21.5°C
For other properties, see Germanium Compounds.

POTASSIUM TETRAIODOMERCURATE (II)
Description: Yellow, deliquescent crystals.
Formula: K_2HgI_4
Constant:
Mol. Wt. 786.48
Toxicity: Highly toxic. See Mercury Compounds.
Disaster Control: Dangerous. See Mercury Compounds.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

POTASSIUM TETRASULFIDE
Description: Red-brown crystals.
Formula: K_2S_4
Constants:
Mol. Wt. 206.46
M. P. 145°C
B. P. Decomp. @850°C
For other properties, see Sulfides.

POTASSIUM THIOANTIMONATE
Description: Yellow crystals.
Formula: $2K_3SbS_4 \cdot 9H_2O$
Constant:
Mol. Wt. 896.8
Toxicity: Highly toxic. See Antimony Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of antimony and oxides of sulfur.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

POTASSIUM THIOARSENATE
Description: Deliquescent crystals.
Formula: K_3AsS_4
Constants:
Mol. Wt. 320.46
M. P. Decomp.
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of arsenic and oxides of sulfur.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

POTASSIUM THIOARSENITE
Description: A solid.
Formula: K_2AsS_3
Constants:
Mol. Wt. 288.4
M. P. Decomposes
Toxicity: Highly toxic. For other properties, see Potassium Thioarsenate.

POTASSIUM THIOCYANATE. See Potassium Sulfocyanate.

POTASSIUM THIOPLATINATE
Description: Blue-gray crystals.
Formula: $K_2Pt_4S_6$
Constants:
Mol. Wt. 1051.51
M. P. Decomp. upon ignition
Density 6.44 @15°C
Toxicity: See Platinum Compounds.

Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

POTASSIUM TRIIODIDE
Description: Monoclinic, dark blue, deliquescent crystals.
Formula: KI_3
Constants:
Mol. Wt. 419.86
M. P. 31°C
B. P. Decomp. @225°C
Density 3.498
Toxicity: See Iodides.
Disaster Control: See Iodides.
Storage and Handling: Section 7

POTASSIUM TRIOXIDE
Synonym: Potassium sesquioxide.
Description: Red crystals (probably a mixture).
Formula: K_2O_3
Constants:
Mol. Wt. 126.19
M. P. 430°C
Toxicity: Highly toxic. See Potassium.

POTASSIUM TRISULFIDE
Description: Yellow crystals.
Formula: K_2S_3
Constants:
Mol. Wt. 174.39
M. P. 252°C
For other properties, see Sulfides.

POTASSIUM m-URANATE
Description: Orange-yellow crystals.
Formula: K_2UO_4
Constant:
Mol. Wt. 380.26
Toxicity: See Uranium Compounds, Soluble.

POTASSIUM URANYL ACETATE
Description: Radioactive crystals.
Formula: $KUO_2(C_2H_3O_2)_2 \cdot H_2O$
Constants:
Mol. Wt. 504.31
M. P. $-H_2O$ @275°C
Density 2.396 @15°C
Toxicity: See Uranium Compounds, Soluble.

POTASSIUM URANYL CARBONATE
Description: Yellow, radioactive crystals.
Formula: $2K_2CO_3 \cdot UO_2CO_3$
Constants:
Mol. Wt. 606.48
M. P. $-CO_2$ @300°C
Toxicity: See Uranium Compounds, Soluble.

POTASSIUM URANYL SULFATE
Description: Radioactive, yellow crystals.
Formula: $K_2SO_4 \cdot UO_2SO_4 \cdot 2H_2O$
Constants:
Mol. Wt. 576.43
M. P. $-2H_2O$ @120°C
Density 3.363 @19.1°C
Toxicity: See Uranium Compounds, Soluble.

POTASSIUM m-VANADATE
Description: Colorless crystals.
Formula: KVO_3
Constant:
Mol. Wt. 138.05
Toxicity: See Vanadium Compounds.

POTASSIUM XANTHATE
Synonym: Potassium ethyl xanthate.
Description: Liquid.
Formula: $C_2H_5OCS_2K$
Constants:
Mol. Wt. 160.3
M. P. 200°C Decomp.
Flash P. 205°C (C.C.)
Density 1.558
Toxicity: See Carbon Disulfide.
Fire Hazard: Moderate, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 9.5% (U.E.L.)
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

POWDERED METALS
Toxicity: See specific metal.
Fire Hazard: Dangerous in dispersed

form when exposed to flame or sparks or by chemical reaction with oxidizers. Many powdered metals can ignite spontaneously in air.
To Fight Fire: Use no water; use powdered graphite, dolomite, sodium chloride, etc. Get instructions from the supplier of the powdered metal.

PRASEODYMIUM
Description: Pale yellow metal.
Formula: Pr
Constants:
At. Wt. 140.92
M. P. 940°C
Density 6.5
Toxicity: Unknown
Radiation Hazard (Section 5): Artificial isotope Pr^{143}, half-life: 13.8 days; emits beta particles of 0.92 mev. The permissible levels are: In body: 29 microcuries; in air: 7.5×10^{-7} microcurie; in water: 0.4 microcurie per milliliter. Hazard Rating, Class II (National Bureau of Standards Handbook No. 42).

Artificial isotope Pr^{144}, half-life: 17.5 minutes; emits beta particles of 3.1 mev and gamma rays of 0.14 mev. The permissible levels are: In body: 5 microcuries; in air: 7×10^{-9} microcurie per milliliter; in water: 4×10^{-2} microcurie per milliliter.

Pr^{144} exists in equilibrium with its parent, Ce^{144}. The hazard rating and permissible levels are given for the equilibrium mixture. Hazard Rating, Class III (National Bureau of Standards Handbood No. 42).
Fire Hazard: Moderate, in the form of dust, when exposed to heat or flame or by chemical reaction. Fine dust ignites readily. See also Powdered Metals.

PRASEODYMIUM BROMATE
Description: Hexagonal, green crystals.
Formula: $Pr(BrO_3)_3 \cdot 9H_2O$
Constants:
Mol. Wt. 686.81
B. P. $-7H_2O$ @100°C
M. P. 56.5°C
For other properties, see Bromates.

PRASEODYMIUM OXALATE
Description: Light green crystals.
Formula: $Pr_2(C_2O_4)_3 \cdot 10H_2O$
Constant:
Mol. Wt. 726.06
Toxicity: Highly toxic. See Oxalates.

PRASEODYMIUM SELENATE
Formula: $Pr_2(SeO_4)_3$
Constants:
Mol. Wt. 710.72
Density 4.30 @15°C
Toxicity: Highly toxic. See Selenium Compounds.

PRASEODYMIUM SULFIDE
Description: Brown powder.
Formula: Pr_2S_3
Constants:
Mol. Wt. 378.04
M. P. Decomposes
Density 5.042 @11°C
For other properties, see Sulfides.

PRIMERS. See Explosives, High.
Shipping Regulations: Section 11.
Coast Guard Classification: Explosive C.

PROCAINE BORATE
Synonym: Borocaine.
Description: Tabular crystals.
Formula: $C_{13}H_{20}N_2O_2 \cdot 5HBO_2$
Constants:
Mol. Wt. 455.5
M. P. 166°C
Toxicity: Moderate. See Procaine Hydrochloride.

PROCAINE HYDROCHLORIDE
Description: Crystals.
Formula: $C_{13}H_{20}N_2O_2 \cdot HCl$
Constants: Mol. Wt. 272.8
M. P. 153 - 156°C
Density 0.707 @17°C
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: Allergen 1
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits

highly toxic fumes of hydrochloric acid.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

PROCAINE NITRATE
Description: Crystals.
Formula: $C_{13}H_{20}N_2O_2 \cdot HNO_3$
Constants:
  Mol. Wt. 299.3
  M. P. 101°C
Toxicity: Moderate. See Procaine Hydrochloride.
Fire Hazard: Moderate. See Nitrates.
Disaster Control: Dangerous. See Nitrates.
Storage and Handling: Section 7

PRODUCER GAS
Toxicity: Highly toxic. See Carbon Monoxide, Methane and Hydrogen.
Fire Hazard: Dangerous, when exposed to flame.
To Fight Fire: Carbon dioxide, dry chemical or water spray (Section 6).
Explosive Range: 20.7 - 73.7%
Disaster Control: Dangerous; shock can shatter the compressed gas containers with explosive force; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PROPANE
Synonym: Dimethylmethane.
Description: Colorless gas.
Formula: $CH_3CH_2CH_3$
Constants:
  Mol. Wt. 44.09
  B. P. −42.1°C
  Freezing P. −187.1°C
  Flash P. −156°F
  Density 0.5853 @−44.5°/4°C
  Autoign. Temp. 874°F
  Vap. D. 1.56
Toxic Hazard Rating:
  Acute Local: 0
  Acute Systemic: Inhalation 1
  Chronic Local: 0
  Chronic Systemic: U
Fire Hazard: Highly dangerous when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or water spray (Section 6).
Explosion Hazard: Severe, when exposed to flame.
Explosive Range: 2.3 - 7.3%
Disaster Control: Dangerous; shock can shatter the compressed gas container with explosive force; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PROPANOL. See Propyl Alcohol.

4-PROPANOL PYRIDINE
Description: Crystals.
Formula: $(CH_2CH_2CH_2OH)C_5H_4N$
Constants:
  Mol. Wt. 137.1
  B. P. 289°C
  Freezing P. 36.7°C
  Density 1.053 @40°C
Toxicity: Probably toxic. See Pyridine.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of nitrogen oxides.
Storage and Handling: Section 7

PROPARGYL ALCOHOL
Synonym: 2-Propyn-1-ol.
Description: A moderately volatile liquid geranium-like odor.
Formula: $HC{\equiv}CCH_2OH$
Constants:
  Mol. Wt. 56.1
  M. P. −17°C
  B. P. 115°C
  Flash P. 97°F (O.C.)
  Density 0.9715 @20°/4°C
  Vap. Press. 11.6 mm @20°C
  Vap. D. 1.93
Toxic Hazard Rating (animal data):
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PROPARGYL BROMIDE
Description: An almost colorless liquid; sharp odor.
Formula: $HC{=}CCH_2Br$
Constants:
  Mol. Wt. 118.97
  B. P. 88 - 90°C
  Freezing P. −61.07°C
  Flash P. 65°F (C.O.C.)
  Density 1.564 - 1.570
  Vap. D. 6.87
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 2; Inhalation 3
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromides; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

PROPENE. See Propylene.

1-PROPENE-2-CHLORO-1,3-DIOL-DIACETATE
Toxic Hazard Rating (animal data):
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

1-PROPENE-1,3-DIOL-DIACETATE
Toxic Hazard Rating (animal data):
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Slight, when heated, it emits acrid fumes (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 3

β-PROPIOLACTONE
Formula: $C_3H_4O_2$
Constants: Mol. Wt. 72.1
  M. P. −33.4°C
  B. P. 155°C (with rapid decomp.)
  Flash P. 165°C
  Density 1.1460 @20°/4°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

PROPIONALDEHYDE
Synonyms: Propyl aldehyde; propylic aldehyde.
Description: Colorless liquid; suffocating odor.
Formula: CH_3CH_2CHO
Constants: Mol. Wt. 58.1
  M. P. −81°C; B. P. 48.8°C
  Flash P. 15°F
  Density 0.807 @20°/4°C
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Disaster Control: Dangerous fire hazard; reacts vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PROPIONIC ACID

Synonym: Methyl acetic acid.
Description: Colorless liquid.
Formula: CH_3CH_2COOH
Constants:
  Mol. Wt. 74.1
  M. P. −22°C
  B. P. 141°C
  Density 0.992
  Vap. Press. 10 mm @39.7°C
  Vap. D. 2.56
Toxicity: Details unknown; probably low.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

PROPIONIC ANHYDRIDE

Synonym: Propanoic anhydride.
Formula: $(CH_3CH_2CO)_2O$
Constants:
  Mol. Wt. 130.14
  M. P. −45°C
  B. P. 167.0°C
  Flash P. 165°F (O.C.)
  Density 1.012
  Vap. Press. 1 mm @20.6°C
  Vap. D. 4.49
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

PROPIONYL CHLORIDE

Synonym: Propanoyl chloride.
Description: Colorless liquid.
Formula: CH_3CH_2COCl
Constants:
  Mol. Wt. 92.5
  M. P. −94°C
  B. P. 80°C
  Flash P. 53°F
  Density 1.065
Toxicity: Highly toxic. See Hydrochloric Acid.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PROPIOPHENONE

Synonym: Ethylphenyl ketone.
Description: Water-white to light amber liquid.
Formula: $C_9H_{10}O$
Constants:
  Mol. Wt. 134.2
  M. P. 21°C
  B. P. 218.0°C
  Flash P. 210°F
  Density 1.012 @20°/20°C
  Vap. Press. 1 mm @50.0°C
Toxicity: Details unknown. See also Ketones.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

n-PROPYL ACETATE

Description: Clear, colorless liquid; pleasant odor.
Formula: $CH_3COOC_3H_7$
Constants:
  Mol. Wt. 102.13
  M. P. −92.5°C
  B. P. 101.6°C
  Flash P. 58°F
  Density 0.887
  Autoign. Temp. 860°F
  Vap. Press. 40 mm @28.8°C
  Vap. D. 3.52
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 1
  Chronic Local: U
  Chronic Systemic: Inhalation 1
MAC: ACGIH (accepted); 200 parts per million in air; 834 milligrams

per cubic meter of air.

Toxicology: This material causes narcosis and is somewhat irritating. However, it is not likely to cause chronic poisoning, since there is definite evidence of habituation to this material. The after-effects are slight and recovery quick from even deep narcosis. The symptoms noted are sleepiness, fatigue, slight stupefaction and retarded respiration. Repeated or prolonged inhalations of high concentrations have been shown to produce irritation and narcosis and in certain cases death, although no industrial injury has been reported as occurring to workmen exposed to it. Isopropyl acetate has been shown to have slightly less narcotic potency than normal propyl acetate.

Treatment and Antidotes: Personnel who show the symptoms of irritation or narcosis from exposure to this material should immediately be removed to fresh air. Recovery is quick and complete. If the exposure has been very severe, consult a physician.

Fire Hazard: Dangerous, when exposed to heat or flame.

Spontaneous Heating: No

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Moderate, when exposed to heat or flame.

Explosive Range: 1.77 - 8.0%

Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Personal Hygiene: Section 2

Storage and Handling: Section 7

n-PROPYL ALCOHOL

Synonym: 1-Propanol; ethyl carbinol.

Description: Clear, odorless liquid; alcohol-like odor.

Constants: Mol. Wt. 60.1
M. P. -127°C B. P. 97.19°C
Flash P. 59°F (C.C.)
Density 0.8044 @20°/4°C
Autoign. Temp. 812°F
Vap. Press. 10 mm @14.7°C
Vap. D. 2.07

Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: Inhalation 1
Chronic Local: U
Chronic Systemic: Inhalation 1

Fire Hazard: Dangerous, when exposed to heat or flame.

Spontaneous Heating: No

Underwriters Laboratory Classification: 55-60.

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Moderate, when exposed to flame.

Explosive Range: 2.5 - 13.5%

Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.

Personnel Protection: Section 3

Ventilation Control (use moderate rate): Section 2

Storage and Handling: Section 7

PROPYL ALDEHYDE

Synonyms: Propylic aldehyde; propionaldehyde.

Description: Colorless liquid; suffocating odor.

Formula: CH_3CH_2CHO

Constants: Mol. Wt. 58.1
M. P. -81°C
B. P. 48°C
Flash P. 15°F
Density 0.807 @20°/4°C

Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U

Fire Hazard: Dangerous, when exposed to heat or flame.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Disaster Control: Dangerous fire hazard; reacts vigorously with oxidizers.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

n-PROPYL BENZENE

Synonym: 1-Phenyl propane.
Description: Clear liquid.
Formula: $C_3H_7C_6H_5$
Constants:
- Mol. Wt. 120.2
- M. P. −99.5°C
- B. P. 159.2°C
- Flash P. 86°F (C.C.)
- Density 0.862
- Vap. Press. 10 mm @ 43.4°C
- Vap. D. 4.14

Toxicity: Details unknown. See also Benzene.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

PROPYL BORATE

Synonym: Tripropyl borate.
Description: Colorless liquid.
Formula: $B(OC_3H_7)_3$
Constants:
- Mol. Wt. 188.1
- B. P. 175°C
- Density 0.867 @ 16°C

Toxicity: See Boron Compounds.
Fire Hazard: Moderate; when heated it emits toxic fumes (Section 6).
Storage and Handling: Section 7

PROPYL BROMIDE

Synonym: 1-Bromopropane.
Description: Liquid.
Formula: $CH_3CH_2CH_2Br$
Constants:
- Mol. Wt. 123.00
- M. P. −110°C
- B. P. 70.9°C
- Density 1.353 @ 20°/4°C

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 2
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Moderate, when heated or exposed to flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; on decomposition, it emits highly toxic fumes of bromides; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

PROPYL "CELLOSOLVE"

Toxicity: Details unknown. See also Glycols.
Fire Hazard: Moderate; when heated, it emits acrid fumes; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

n-PROPYL CHLORIDE

Synonym: 1-Chloropropane.
Description: Colorless liquid; chloroform-like odor.
Formula: $CH_3CH_2CH_2Cl$
Constants:
- Mol. Wt. 78.54
- M. P. −122.8°C
- B. P. 47.2°C
- Flash P. 0°F
- Density 0.890
- Vap. D. 2.71

Toxic Hazard Rating:
- Acute Local: Irritant 1
- Acute Systemic: Inhalation 2
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 2.6 - 10.5%
Disaster Control: Dangerous. Keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

PROPYL CHLOROSULFONATE

Description: Liquid.
Formula: $CH_3CH_2CH_2OSO_2Cl$

Constants:
Mol. Wt. 158.61
B. P. 70 - 72°C @20 mm
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of sulfur. A military poison.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PROPYLENE

Synonym: Propene.
Description: A gas.
Formula: C_3H_6
Constants: Mol. Wt. 42.1
M. P. −185°C
B. P. −47.7°C
Density (liquid) 0.581 @0°C
Autoign. Temp. 927°F
Vap. Press. 10 atm. @19.8°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or water spray (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame. Under unusual conditions, i.e., 955 atmospheres pressure and 327°C, it has been known to explode.
Disaster Control: Dangerous; shock can shatter the compressed gas container with explosive force; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: See Liquefied Petroleum Gas.
Coast Guard Classification: Inflammable gas; red gas label.
MCA warning label.

PROPYLENE CARBONATE

Description: A clear liquid.
Formula: $CH_3CHCH_2CO_3$
Constants:
Mol. Wt. 102.09
B. P. 242.1°C
Freezing P. −48.8°C
Flash P. 275°F (O.C.)
Density 1.2069 @20°/20°C
Vap. Press. 0.03 mm @20°C
Toxicity: Unknown
Fire Hazard: Slight; when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Can react with oxidizing materials.
Storage and Handling: Section 7

PROPYLENE CHLOROBROMIDE

Description: Colorless liquid.
Formula: $CH_3CHBrCH_2Cl$
Constants:
Mol. Wt. 157.5
B. P. 117 - 118.5°C
Freezing P. < −20°C
Density 1.540 @25°/25°C
Vap. D. 5.47
Toxicity: Probably toxic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

PROPYLENE CHLOROHYDRIN

Synonyms: Chloro-isopropyl alcohol; 1-chloro-2-propanol.
Description: Colorless liquid; mild, non-residual odor.
Formula: $CH_2ClCHOHCH_3$
Constants:
Mol. Wt. 94.54
B. P. 127.0°C
Flash P. 125°F (C.C.)
Density 1.103 @20°C
Vap. D. 3.26
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: Skin Absorption 1
Chronic Local: U
Chronic Systemic: Skin Absorption 1
Fire Hazard: Moderate, when

exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react with oxidizing materials.
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
MCA warning label.

PROPYLENE DIAMINE

Description: Colorless liquid.
Formula: $CH_3CH(NH_2)CH_2NH_2$
Constants:
  Mol. Wt. 74.13
  B. P. 119 - 120°C
  Flash P. 120°F (O.C.)
  Density 0.87 @15°C
  Vap. D. 2.56
Toxicity: Corrosive liquid. See also Ammonia.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; on heating to decomposition, it emits toxic fumes of nitrogen oxides; can react with oxidizing materials.
Storage and Handling: Section 7

PROPYLENE DIBROMIDE

Description: Colorless liquid.
Formula: $CH_3CHBrCH_2Br$
Constants: Mol. Wt. 201.9
  M. P. −55°C
  B. P. 139.6 - 142.6°C
  Freezing P. < -75°C
  Density 1.940 @25°/25°C
  Vap. D. 7.0
Toxicity: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes of bromides.
Storage and Handling: Section 7

PROPYLENE DICHLORIDE

Description: Colorless liquid.
Formula: $CH_2ClCHClCH_3$
Constants:
  Mol. Wt. 112.99
  B. P. 95.4°C
  Freezing P. < -70°C
  Flash P. 60°F (C.C.)
  Density 1.1593 @20°/20°C
  Autoign. Temp. 1035°F
  Vap. D. 3.89
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: U
MAC: 75 parts per million in air.
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 3.4 - 14.5%
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

PROPYLENE FLUOROHYDRIN

Synonym: Fluoroisopropyl alcohol.
Description: Colorless liquid.
Formula: $CH_2FCHOHCH_3$
Constant:
  Mol. Wt. 78.1
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

PROPYLENE GLYCOL

Synonyms: 1,2-Propanediol; 1,2-dihydroxypropane.
Description: Colorless liquid; practically odorless.
Formula: $CH_2OHCHOHCH_3$
Constants:
  Mol. Wt. 76.1
  B. P. 188.2°C

Flash P. 210°F (O. C.)
Density 1.0362 @25°/25°C
Autoign. Temp. 790°F
Vap. Press. 0.08 mm @20°C
Vap. D. 2.62
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1
Acute Systemic: Ingestion 1
Chronic Local: Irritant 1; Allergen 1
Chronic Systemic: Ingestion 1
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 2.62 - 12.55%
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PROPYLENE GLYCOL-4-BIPHENYLYL ETHER

Synonyms: 1-(4-Biphenylyloxy)-2-propanol.
Description: White, crystalline solid.
Formula: $C_6H_5C_6H_4OCH_2CH(OH)CH_3$
Constants:
Mol. Wt. 228.3
M. P. 121 - 123°C
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

PROPYLENE GLYCOL sec-BUTYL PHENYL ETHER

Synonyms: 1-(o-sec-Butyl phenoxy)-2-propanol.
Description: Slightly yellow liquid.
Formula:
$C_2H_5CH(CH_3)C_6H_4OCH_2CH(OH)CH_3$
Constants:
Mol. Wt. 208.3
M. P. < -20°C
B. P. 276.8°C
Flash P. 270°F
Density 0.992 @25°/25°C
Vap. D. 7.2
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Details unknown See also Ethers.
Storage and Handling: Section 7

PROPYLENE GLYCOL p-tert-BUTYLPHENYL ETHER

Synonyms: 1-(p-tert-Butylphenoxy).2-propanol.
Description: White solid.
Formula:
$(CH_3)_3CC_6H_4OCH_2CH(OH)CH_3$
Constants:
Mol. Wt. 208.3
M. P. 33°C
B. P. 288.8°C
Flash P. 290°F
Density 0.979 @60°/60°C
Vap. D. 7.2
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

PROPYLENE GLYCOL CHLOROPHENYL ETHER

Synonyms: 1-(o-Chlorophenoxy)-2-propanol.
Description: Slightly yellow liquid.
Formula:
$ClC_6H_4OCH_2CH(OH)CH_3$
Constants:
Mol. Wt. 186.6
M. P. < -20°C
B. P. 272.3°C
Flash P. 270°F
Density 1.201 @25°/25°C
Vap. D. 6.45
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; on heating to decomposition, it emits toxic fumes of chlorides; can react

with oxidizing materials.
Storage and Handling: Section 7

PROPYLENE GLYCOL DIACETATE

Toxicity: Details unknown. See Glycols.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

PROPYLENE GLYCOL-2,4-DICHLOROPHENYL ETHER

Synonyms: 1-(2,4-Dichlorophenoxy)-2-propanol.
Description: Slightly yellow liquid.
Formula: $Cl_2C_6H_3OCH_2CH(OH)CH_3$
Constants:
Mol. Wt. 221.1
M. P. 9.5°C
B. P. 297.7°C
Flash P. 335°F
Density 1.309 @25°/25°C
Vap. D. 7.6
Toxicity: Details unknown. See Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, form, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

PROPYLENE GLYCOL METHYL ETHER

Description: Colorless liquid.
Formula: $CH_3OCH_2CHOHCH_3$
Constants:
Mol. Wt. 90.1
M. P. -96.7°C
B. P. 120°C
Flash P. 100°F
Density 0.919 @25°/25°C
Toxicity: Unknown. See Glycols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

PROPYLENE GLYCOL MONOETHYL ETHER

Description: Clear liquid.
Formula: $CH_3CHOHCH_2OC_2H_5$
Constants:
Mol. Wt. 104.15
B. P. 130°C
Toxicity: Details unknown. See Glycols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

PROPYLENE GLYCOL MONOMETHYL ETHER

Description: Liquid.
Formula: $CH_3OC_3H_6OH$
Constants:
Mol. Wt. 90.1
M. P. -96.7°C
B. P. 120°C
Flash P. 100°F
Density 0.919 @25°/25°C
Vap. D. 3.11
Toxicity: Details unknown. See Glycols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

PROPYLENE GLYCOL PHENYL ETHER

Description: Liquid.
Formula: $C_6H_5OCH_2CH(OH)CH_3$
Constants:
Mol. Wt. 152.2
B. P. 240°C
Freezing P. 13 - 18°C
Flash P. 275°F
Density 1.063 @25°/4°C
Vap. D. 5.25
Toxicity: Details unknown. See Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

PROPYLENE IMINE

Description: Liquid.
Formula: $NHCH_2CHCH_3$

Constants:
  Mol. Wt. 58.10
  Vap. D. 2.0
Toxic Hazard Rating:
  Acute Local: Irritant 2
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: U
MAC: ACGIH (tentative); 25 parts per million in air.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits toxic fumes of oxides of nitrogen; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

PROPYLENE OXIDE

Synonyms: 1,2-Epoxypropane; propene oxide; methyl oxirane.
Description: Colorless liquid; ethereal odor.
Formula: OCH_2CHCH_3
Constants:
  Mol. Wt. 58.08
  B. P. 33.9°C
  Freezing P. −104.4°C
  Flash P. −35°F (T.O.C.)
  Density 0.8304 @20°/20°C
  Vap. Press. 400 mm @17.8°C
  Vap. D. 2.0
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: Irritant 1
  Chronic Systemic: U
Fire Hazard: Highly dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Severe, when exposed to flame.
Explosive Range: 2.1 - 21.5%
Disaster Control: Dangerous; can react vigorously with oxidizing materials. Keep away from heat and open flame!
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  Coast Guard Classification: Inflammable liquid; red label.

PROPYL ETHER

Synonym: Dipropyl ether.
Description: Colorless liquid.
Formula: $(C_3H_7)_2O$
Constants:
  Mol. Wt. 102.2
  M. P. −122°C
  B. P. 90°C
  Density 0.736 @20°/4°C
Toxicity: See Ethers.
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Details unknown. See Ethers.
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

n-PROPYL FORMATE

Synonym: Propyl methanoate.
Description: Colorless liquid; pleasant odor.
Formula: $C_3H_7CHO_2$
Constants:
  Mol. Wt. 88.1
  M. P. −93°C
  B. P. 82°C
  Flash P. 27°F (C.C.)
  Density 0.901 @20°C
  Vap. Press. 100 mm @29.5°C
  Vap. D. 3.03
Toxicity: Details unknown. See n-Propyl Alcohol and Formic Acid.
Fire Hazard: Dangerous; when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

PROPYL GALLATE

Synonym: Propyl-3,4,5-trihydroxy benzoate.
Description: Odorless, fine, ivory powder.
Formula: $(HO)_3C_6H_2COOC_3H_7$
Constants:
  Mol. Wt. 212.2
  M. P. 147 - 149°C
Toxicity: Details unknown. See n-Propyl Alcohol.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

PROPYL IODIDE

Synonym: 1-Iodopropane.
Description: Colorless to yellow liquid.
Formula: $CH_3CH_2CH_2I$
Constants:
  Mol. Wt. 170.0
  M. P. -98°C
  B. P. 103°C
  Density 1.747 @20°/4°C
Toxicity: Details unknown. Probably toxic. See Halogenated Hydrocarbons.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of iodides; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

PROPYL NITRATE

Description: Liquid.
Formula: $CH_3CH_2CH_2NO_3$
Constants:
  Mol. Wt. 105.1
  B. P. 110.5°C
  Density 1.058 @20°/4°C
For other properties, see Nitrates.

PROPYL NITRITE

Description: Liquid.
Formula: $CH_3CH_2CH_2ONO$
Constants:
  Mol. Wt. 89.1
  B. P. 57°C
  Density 0.935
For other properties, see Nitrates.

n-PROPYL PROPIONATE

Description: Clear liquid.
Formula: $CH_3CH_2COOCH_2CH_2CH_3$
Constants:
  Mol. Wt. 116.16
  M. P. -76°C
  B. P. 122.4°C
  Flash P. 175°F (O.C.)
  Density 0.885
  Vap. Press. 10 mm @19.4°C
Toxicity: Details unknown. See n-Propyl Alcohol.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

n-PROPYL SILICATE

Formula: $(C_3H_7O)_4Si$
Constants:
  Mol. Wt. 264.4
  B. P. 226°C
  Density 0.915
Toxicity: Details unknown. See n-Propyl Alcohol.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

PROPYL SULFATE

Synonym: Di-n-propyl sulfate.
Description: Colorless, oily, liquid.
Formula: $(CH_3CH_2CH_2)_2SO_4$
Constants:
  Mol. Wt. 182.2
  M. P. 140 - 170°C Decomposes
  B. P. 120°C @20 mm
  Density 1.11 @22.5°C
  Vap. D. 6.28
Toxicity: Details unknown.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

PROPYL SULFIDE

Synonym: 1-Propyl thiopropane.

Description: Liquid.
Formula: $(C_3H_7)_2S$
Constants:
  Mol. Wt. 118.2
  B. P. 142°C
  Freezing P. -101.9°C
  Density 0.814 @17°C
  Vap. D. 4.08
Toxicity: Details unknown. See Sulfides.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

PROPYL THIOCYANATE
Description: Clear liquid.
Formula: $CH_3CH_2CH_2SCN$
Constants:
  Mol. Wt. 101.13
  Vap. D. 3.49
Toxicity: Probably slight. See Thiocyanates.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of cyanides; can react with oxidizing materials.
Storage and Handling: Section 7

PROPYL TRICHLOROSILANE
Formula: $C_3H_7SiCl_3$
Constants: Mol. Wt. 177.6
  Vap. D. 6.15
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Corrosive liquid; white label.
  Coast Guard Classification: Corrosive liquid; white label.

PROPYL-3, 4, 5-TRIHYDROXY BENZOATE. See Propyl Gallate.

2-PROPYN-1-OL. See Propargyl Alcohol.

PROTACTINIUM
Synonyms: Uranium X_2; UX_2
Description: Shiny metallic mass.
Formula: Pa
Constant:
  At. Wt. 234
Radiation Hazard (Section 5): Natural isotope Pa^{234} (UX_2), half-life: 1.2 minutes; emits beta particles of 2.32 mev and gamma rays of 0.39 mev.
Fire Hazard: Moderate, in the form of dust, when exposed to heat or flame or by chemical reaction. See also Powdered Metals (Section 6).
Ventilation Control (use high rate): Section 2
Personal Hygiene: Section 3
First Aid: Section1

PRUSSIATE OF SODA. See Sodium Ferricyanide and Sodium Ferrocyanide.

PRUSSIC ACID. See Hydrocyanic Acid.

PSEUDOACONITINE
Synonym: Feraconitine; nepaline.
Description: White crystals or syrupy mass.
Formula: $C_{36}H_{51}NO_{12}$
Constants:
  Mol. Wt. 689.78
  M. P. 212°C (decomp.)

Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated, it emits highly toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

PTOMAINES

Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3
Chronic Local: U
Chronic Systemic: U
Toxicology: These are exceedingly toxic compounds commonly formed in putrefying proteins, dead bodies, decayed meat and fish. They have been prepared synthetically and are derivatives of ethers of the polyhydric alcohols. "Ptomaine poisoning" is usually a misnomer for other forms of food poisoning.

PULSATILLA POWDER

Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Slight, when exposed to flame.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 3

PYRETHRIN I

Synonym: Pyrethrolone ester of chrysanthemum monocarboxylic acid.
Description: Viscous liquid.
Formula: $C_{21}H_{28}O_3$
Constants:
Mol. Wt. 328.4
B. P. 170°C @0.1 mm Decomp.
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: Allergen 1
Chronic Systemic: Ingestion 1; Inhalation 1
Fire Hazard: Slight, when heated, it emits acrid fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene Section 3
Storage and Handling: Section 7

PYRETHRIN II

Synonym: Pyrethrolone ester of chrysanthemum dicarboxylic acid monomethyl ester.
Description: Viscous liquid.
Formula: $C_{22}H_{28}O_5$
Constants:
Mol. Wt. 372.4
B. P. 200°C @0.1 mm Decomp.
Toxicity: Less than Pyrethrin I.

PYRIDINE

Description: Colorless liquid; sharp, penetrating, empyreumatic odor; burning taste.
Formula: NCHCHCHCHCH
Constants:
Mol. Wt. 79.10
B. P. 115.3°C
Freezing P. −42°C
Flash P. 68°F (C.C.)
Density 0.982
Autoign. Temp. 900°F
Vap. Press. 10 mm @13.2°C
Vap. D. 2.73
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
MAC: ACGIH (tentative); 10 parts per million in air.
Toxicology: Chronic exposure has been known to cause liver and kidney damage.
Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Severe, in the form of vapor, when exposed to flame.
Explosive Range: 1.8 - 12.4%
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of cyanides; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Combustible liquid; inflammable liquid, red label.
  MCA warning label

PYRIDINE-N-OXIDE
Description: Water-soluble crystals.
Formula: C_5H_5NO
Constants:
  Mol. Wt. 95.1
  Freezing P. 67.0°C
Toxicity: Details unknown. See Pyridine.
Fire Hazard: Moderate, when exposed to heat or flame.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of oxides of nitrogen; can react with oxidizing materials.
Storage and Handling: Section 7

PYRIDINIUM PERCHLORATE, See Perchlorates.

PYRIDYL MERCURIC CHLORIDE. See Mercury Compounds, Organic.

PYRO-ARSENIC ACID
Description: Colorless crystals.
Formula: $H_4As_2O_7$
Constants:
  Mol. Wt. 265.9
  M. P. Decomp. @206°C
For other properties, see Arsenic Compounds.

PYROCATECHOL
Synonyms: 1,2-Benzendiol; catechol; pyrocatechin; o-dihydroxy benzene.
Description: Colorless crystals.
Formula: $C_6H_4(OH)_2$
Constants:
  Mol. Wt. 110.11
  M. P. 105°C
  B. P. 240°C
  Flash P. 261°F (C.C.)
  Density 1.371 @15°C
  Vap. Press. 10 mm @118.3°C
  Vap. D. 3.79
Toxic Hazard Rating:
  Acute Local: Irritant 3; Allergen 1
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
  Chronic Local: Allergen 2
  Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated, it emits highly toxic fumes; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

PYROCELLULOSE. See Cellulose Nitrate.

PYROGALLOL
Synonyms: Pyrogallic acid; 1,2,3-benzentriol; trihydroxybenzene.
Description: White, lustrous crystals.
Formula: $C_6H_3(OH)_3$
Constants:
  Mol. Wt. 126.11
  M. P. 133 - 134°C
  B. P. 309°C
  Density 1.453 @4°/4°C
  Vap. Press. 10 mm @167.7°C
Toxic Hazard Rating:
  Acute Local: Irritant 3
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
  Chronic Local: U
  Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Disaster Control: Dangerous; when heated it may emit highly toxic fumes.

Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PYROLIGNEOUS ACID

Synonym: Wood vinegar.
Description: Yellowish, acidic liquid.
Formula: $HC_2H_3O_2$ (6%)
Toxic Hazard Rating:
  Acute Local: Irritant 1; Allergen 1
  Acute Systemic: U
  Chronic Local: Irritant 1; Allergen 1
  Chronic Systemic: U

PYROMELLITIC ACID

Synonyms: (PMA); 1, 2, 4, 5-Benzene tetracarboxylic acid.
Description: Off-white powder.
Formula: $C_6H_2(COOH)_4$
Constants:
  Mol. Wt. 254.15
  M. P. 257 - 265°C decomp.
  Density 0.43
Toxicity: Unknown
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

PYROMUCIC ALDEHYDE

Synonyms: Furfural; 2-furaldehyde.
Description: Colorless, oily liquid.
Formula: $C_5H_4O_2$
Constants:
  Mol. Wt. 96.1
  M. P. −36.5°C
  B. P. 161.8°C
  Flash P. 140°F (C. C.)
  Density 1.563 @25°/4°C
  Autoign. Temp. 392°C
Toxicity: Moderate. See Aldehydes. Ingestion of small quantities can cause a persistent headache.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

PYROPHOSPHORIC ACID

Description: Colorless, hygroscopic needles or liquid.
Formula: $H_4P_2O_7$
Constants:
  Mol. Wt. 178.0
  M. P. 61°C
Toxicity: Moderate. See Phosphoric Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus.
Storage and Handling: Section 7

PYROPHOSPHOROUS ACID

Description: Needles.
Formula: $H_4P_2O_5$
Constants:
  Mol. Wt. 145.99
  M. P. 38°C
  B. P. Decomp. @139°C
Toxicity: Moderate, See Phosphoric Acid.
Explosion Hazard: Unknown.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus.
Storage and Handling: Section 7

PYROSULFURIC ACID

Synonym: Disulfuric acid.
Description: Colorless to yellowish crystals.
Formula: $H_2S_2O_7$
Constants: Mol. Wt. 178.2
  M. P. 35°C
  B. P. Decomposes
  Density 1.89
Toxicity: Very corrosive. See Sulfuric Acid.
Fire Hazard: Moderate, by chemical reaction. It reacts violently with organic materials containing hydrogen and oxygen (Section 6).
Disaster Control: Dangerous. See Sulfuric Acid.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

PYROSULFURYL CHLORIDE

Synonym: Disulfuryl chloride.
Description: Colorless, mobile, fuming liquid.
Formula: $S_2O_5Cl_2$
Constants:
  Mol. Wt. 215.03
  M. P. -39°C to -37°C
  B. P. 140°C
  Density Gas = 9.6 g/l; Liquid = 1.818 @11°/4°C

Toxicity: Very corrosive. See Hydrochloric Acid.
Disaster Control: See Hydrochloric Acids.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Corrosive liquid; white label.
  Coast Guard Classification: Corrosive liquid; white label.

PYROXYLIN PLASTIC. See Cellulose Nitrate.
Shipping Regulations: Section 11.
  Coast Guard Classification (rolls, rods, sheets, tubes): Inflammable solid; yellow label.

PYROXYLIN PLASTIC, SCRAP. See Cellulose Nitrate.
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid; yellow label.

PYROXYLIN SOLUTION. See Cellulose Nitrate.
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Combustible liquid; inflammable liquid, red label (see Solvents N. O. S.).

PYROXYLIN SOLVENT, N. O. S.
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Combustible liquid; inflammable liquid, red label.

PYRROLE
Description: Colorless liquid; darkens on standing; mild odor.
Formula: C_4H_5N
Constants:
  Mol. Wt. 67.09
  B. P. 129°C
  Freezing P. −24°C
  Flash P. 102°F (T. C. C.)
  Density 0.968 @20°/4°C
  Vap. D. 2.31
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: Ingestion 2; Inhalation 2
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

PYRROLIDINE
Description: Colorless, mobile liquid; penetrating, amine-like odor.
Formula: C_4H_9N
Constants:
  Mol. Wt. 71.12
  B. P. 86 - 87°C
  Freezing P. −63°C
  Flash P. 37°F (T. C. C.)
  Density 0.8618 @20°/4°C
  Vap. Press. 128 mm @39°C
  Vap. D. 2.45
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: Ingestion 2; Inhalation 2
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

2-PYRROLIDONE
Description: A colorless liquid.
Formula: $H\underline{NCH_2CH_2CH_2C}O$

Constants:
  Mol. Wt. 85.11
  M. P. 25°C
  B. P. 245°C
  Flash P. 290°F
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react with oxidizing materials
Storage and Handling: Section 7

PYRUVIC ALDEHYDE

Synonym: Pyruvaldehyde.
Description: Yellow, mobile liquid; pungent odor.
Formula: CH_3COCHO
Constants: Mol. Wt. 72.06
  B. P. 72°C
  Density 1.20 @20°/20°C
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1; Inhalation 1
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

Q

QUARTZ
Synonyms: Cristobalite; silicon dioxide.
Description: Cubic, colorless crystals.
Formula: SiO_2
Constants:
  Mol. Wt. 60.06
  M. P. 1710°C
  B. P. 2230°C
  Density 2.32
Toxic Hazard Rating:
  Acute Local: Inhalation 2
  Acute Systemic: 0
  Chronic Local: Inhalation 3
  Chronic Systemic: Inhalation 2
MAC: ACGIH (accepted); 5 million particles per cubic foot (over 70% quartz); 10 million particles per cubic foot (10 - 70% quartz).
Ventilation Control (use normal rate): Section 2

QUASSIA
Synonym: Bitter wood tree.
Description: Wood or bark.
Toxic Hazard Rating:
  Acute Local: Ingestion 1
  Acute Systemic: Ingestion 1
  Chronic Local: U
  Chronic Systemic: U
Toxicology: Large doses by mouth may produce nausea and vomiting; an insecticide.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: Slight, in the form of dust, when exposed to heat or flame.
Personal Hygiene: Section 3
Storage and Handling: Section 7

QUENCHING OIL
Description: An oil.
Constants:
  Flash P. 365°F (C.C.)
  Density 0.9
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

QUICKLIME. See Calcium Oxide.
Shipping Regulations: Section 11.
  Coast Guard Classification:
    Hazardous article.

QUICKSILVER. See Mercury.

QUININE
Description: Bulky, white amorphous powder or crystals; bitter taste.
Formula: $C_{20}H_{24}N_2O_2$
Constants:
  Mol. Wt. 324.4
  M. P. 174.9°C
Toxic Hazard Rating:
  Acute Local: Irritant 2; Allergen 1
  Acute Systemic: Ingestion 2
  Chronic Local: Allergen 1
  Chronic Systemic: Ingestion 2
Toxicology: Upon contact with this material, the eyes become swollen, watery and exude a sticky, viscous liquid which forms yellowish crusts. Upon ingestion, it causes dilation of the pupils. The optic nerve becomes pale and atrophic and the retina shows thready arteries, ptosis and clonic spasms of the lids result. It may cause atrophy of the optic nerve. Vision returns in from 24 to 28 hours and gradually improves. Quinine dermatitis is an occupational hazard to barbers particularly and generally to people who work with quinine tonics, medicaments, or cosmetics. Quinine has no influence upon sound skin, but it is distinctly irritant to mucous membranes and raw surfaces. Internally it can cause a sense of fullness in the head, tinnitis aureum, slight deafness, disorders of vision and sometimes blindness.

Its physiological effects vary with the individual. Occasionally, it can cause cutaneous eruptions, such as erythema, urticaria, herpes, purpuria, and even gangrenous affections.
Treatment and Antidotes: Wash out stomach. There are no specific antidotes. Treatment is symptomatic.
Fire Hazard: Slight; when heated to decomposition it emits toxic fumes of oxides of nitrogen.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

QUININE ACETATE. See Quinine.

QUININE ARSENATE
Description: Fine needles or crystals.
Formula:
$3(C_{20}H_{24}N_2O_2)2H_3AsO_4 \cdot 5H_2O$
Constant:
Mol. Wt. 1346
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

QUININE BISULFATE. See Quinine.

QUININE CACODYLATE
Description: White powder.
Formula:
$C_{20}H_{24}N_2O_2(CH_3)_2AsO_2H$
Constant:
Mol. Wt. 462.4
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

QUININE CHLORATE
Description: Crystals.
Formula: $C_{20}H_{24}N_2O_2HClO_3 \cdot 2H_2O$
Constants:
Mol. Wt. 444.9
M. P. Explodes.
Toxicity: Highly toxic. See Quinine.
Fire Hazard: Dangerous. See Chlorates.
Explosion Hazard: Moderate, when shocked or exposed to heat. See Chlorates.
Disaster Control: Dangerous; shock will explode it; when heated to decomposition it emits highly toxic fumes of oxides of nitrogen and chlorides; can react vigorously with reducing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

QUININE HYDROBROMIDE. See Quinine.

QUININE HYDROCHLORIDE. See Quinine.

QUININE SALICYLATE. See Quinine.

QUINOLINE
Synonyms: Chinoline; leukol.
Description: Refractive, colorless liquid; peculiar odor.
Formula: $C_6H_4NCHCHCH$
Constants: Mol. Wt. 129.2
M. P. −19.5°C
B. P. 237.7°C
Density 1.0900 @25°/4°C
Autoign. Temp. 896°F
Vap. Press. 1 mm @59.7°C
Vap. D. 4.45
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
Caution: May produce retinitis similar to that caused by naphthalene but without causing opacity of the lens.
Fire Hazard: Slight, when exposed to heat (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits toxic fumes of nitrogen oxides.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

8-QUINOLINOL
Formula: C_9H_7NO
Toxicity: Details unknown; a fungicide.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6)
Storage and Handling: Section 7

8-QUINOLINOL BENZOATE

Toxicity: Details unknown; a fungicide.

Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).

Storage and Handling: Section 7

QUINONE

Synonyms: Benzoquinone; chinone.

Description: Yellow crystals; characteristic, irritating odor.

Formula: OC_6H_4O

Constants:
Mol. Wt. 108.09
M. P. 115.7°C
B. P. Sublimes
Density 1.318 @20°/4°C

Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Irritant 2
Chronic Systemic: Ingestion 3; Inhalation 3

MAC: ACGIH (tentative): 0.1 parts per million in air.

Toxicology: Quinone has a characteristic, irritating odor. It can cause severe local damage to the skin and mucous membranes by contact with it in the solid state, in solution, or in the form of condensed vapors. Locally it can cause discoloration, severe irritation, erythema, swelling and the formation of papules and vesicles, whereas prolonged contact may lead to necrosis. When the eyes become involved, it can cause dangerous disturbances of vision. A case is reported where ulceration of the cornea resulted from brief exposure to a high concentration of the vapor. An accepted criterion for regulating workroom concentration of this material in the air has been the comfort of personnel involved, as judged by eye irritation, conjunctivitis, photophobia, moderate lachrymation, and burning sensations. It has been found that personnel can develop corneal injury of two types due to this material. One type is a typical superficial greenish-brown stain or grayish-white opacity varying in size and involving all the layers of the cornea. In a few cases there has been an appreciable loss of vision. The eye stain is probably an end product of the oxidation of quinone to hydroquinone and the subsequent polymerization of this material. Its odor becomes perceptible at or just above 0.1 ppm and is quite definite in the region of 0.15 ppm and irritating at 0.5 ppm.

Treatment and Antidotes: Personnel who show the toxic symptoms noted above when exposed to this material should be removed from exposure and the symptoms will rapidly and completely disappear.

Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

QUINOSOL

Synonyms: Chinosol; oxyquinoline potassium sulfate.

Description: Yellow crystalline powder.

Formula: $C_9H_6NOSO_3K \cdot H_2O$

Toxicity: Details unknown; probably low; a fungicide.

Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).

Storage and Handling: Section 7

R

RADIOACTIVE MATERIALS. See individual isotopes.

Shipping Regulations: Section 11.
 I.C.C. Classification: See Section 11.
 Coast Guard Classification:
  Groups I and II: Poison D, Poison Radioactive Materials label (red).
  Group III: Poison D: Poison Radioactive Materials label (blue).
  Low Activity: Poison D.

RADIUM

Description: Silver-white metal.
Formula: Ra
Constants:
 Mol. Wt. 226.05
 M. P. 960°C
 B. P. 1140°C
 Density 5
Toxicity: See Radiation Hazard below.

Radiation Hazard (Section 5): Natural isotope Ra^{224} (Thorium X), half-life: 3.64 days; emits gamma rays of about 0.25 mev. Ra^{224} is a member of the thorium series. It has been used as a short-lived alpha emitter in radio-therapy of skin diseases, and in the preparation of luminous paints. Rn^{224} is a source of thoron and the recommendations described under thoron (Rn^{220}) should be followed.

Natural isotope Ra^{226} (Radium), half-life: 1600 years; emits alpha particles of 4.8 mev and gamma rays of 0.19 mev. The permissible levels are: In body: 0.1 microcurie; in air: 8×10^{-12} microcurie per milliliter; in water: 4×10^{-8} microcurie per milliliter.

Remarks: Ra^{226} is a member of the uranium series. The permissible levels shown include the effects of the daughters of Ra^{226} when radium is taken up by the bone. Radium replaces calcium in the bone structure and is a source of irradiation to the blood forming organs. The ingestion of luminous dial paint prepared from radium was the cause of death of many of the early dial painters before the hazard was fully understood. The data on these workers has been the source of many of the radiation precautions and the maximum permissible levels for internal emitters which are now accepted. Ra^{226} is the parent of radon and the precautions described under radon (Rn^{222}) should be followed.

Natural isotope Ra^{228} (Mesothorium-1), half-life: 6.7 years; emits beta particles of very low energy. Ra^{228} is a member of the thorium series. It was a common constituent of luminous paints, and while its low β energy was not a hazard, its daughters (Ac^{228} and Th^{228}) may have been a causative agent in the deaths of radium dial painters following the World War I. Its metabolism is the same as any other radium isotope and it is a source of thoron. The precautions recommended under thoron (Rn^{220}) should be followed.

Disaster Control: Highly dangerous; must be kept heavily shielded with lead and stored away from possible dissemination by explosion, flood, etc.
Ventilation Control (use high rate): Sections 5 and 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Shipping Regulations: Section 11.

RADIUM BROMIDE

Description: Colorless-yellowish crystals.
Formula: $RaBr_2$
Constants:
 Mol. Wt. 385.88

M. P. 728°C
Density 5.79
Toxicity: See Radium.
Radiation Hazard: See Radium.

RADIUM CARBONATE
Description: White or slight brownish crystals.
Formula: $RaCO_3$
Constant:
Mol. Wt. 286.06
Toxicity: See Radium.

RADIUM CHLORIDE
Description: Monoclinic, colorless-yellowish crystals.
Formula: $RaCl_2$
Constants:
Mol. Wt. 296.96
M. P. 1000°C
Density 4.91
Toxicity: See Radium.

RADIUM EMANATION. See Radon, and Section 5.

RADIUM IODATE
Description: White powder.
Formula: $Ra(IO_3)_2$
Constant:
Mol. Wt. 575.89
Toxicity: See Radium.
Radiation Hazard: See Radium.
Fire Hazard: See Iodates.
Disaster Control: See Iodates.
Storage and Handling: Section 7

RADIUM SULFATE
Description: Colorless crystals.
Formula: $RaSO_4$
Constant:
Mol. Wt. 322.12
Toxicity: See Radium.

RADON
Synonyms: Niton; radium emanation.
Description: Colorless gas; opaque crystals.
Formula: Rn
Constants:
Mol. Wt. 222.00
M. P. −110°C
B. P. −61.8°C
Density 9.73 g/l; liquid = 4.4 @ −62°C; solid = 4
Toxicity: See Radiation Hazard below.
Radiation Hazard (Section 5): Natural isotope Rn^{222} (Radon), half-life: 3.825 days; emits alpha particles of 5.49 mev. The permissible levels are: In air: 10^{-8} microcurie per milliliter; in water: 2×10^{-6} microcurie per milliliter. Rn^{222} is a member of the uranium series. The permissible levels are given for Rn^{222} in equilibrium with its daughters. The chief hazard from this isotope is inhalation of the gaseous element and its solid daughters which are collected on the normal dust of the air. This material is deposited in the lung and has been considered to be a major causative agent in the high incidence of lung cancer found in German and Czechoslovakian uranium miners. Radon and its daughters build up to an equilibrium value in about a month from radium compounds, while the build-up from uranium compounds is negligible. Good ventilation of areas where radium is handled or stored is recommended to prevent accumulation of hazardous concentrations of radon and its daughters.
Ventilation Control (use high rate): Section 2

RAGS, OILY
Toxicity: A variable allergen.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

RAGS, WET
Toxicity: A weak allergen.
Fire Hazard: Slight, when exposed to heat or flame or by chemical reaction (Section 6).
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable solid; yellow label.

Coast Guard Classification: Inflammable solid; yellow label.

RAPESEED OIL
Synonym: Colza oil.
Constants: Flash P. 325°F (C.C.)
Solidifying P. −2 to −10°C
Density 0.915
Autoign. Temp. 836°F
Toxicity: Details unknown; a fungicide for plants.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: Yes
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

RATIONITE. See Dimethyl Sulfate and Chlorosulfonic Acid.

RESORCINOL
Synonyms: 1,3-Benzendiol; resorcin; m-dihydroxy benzene.
Description: Very white crystals; become pink on exposure to light when not perfectly pure; unpleasant sweet taste.
Formula: $C_6H_4(OH)_2$
Constants:
Mol. Wt. 110.11
M. P. 110°C
B. P. 276.5°C
Flash P. 261°F (C.C.)
Density 1.285 @15°C
Autoign. Temp. 648°F
Vap. Press. 1 mm @108.4°C
Vap. D. 3.79
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Chronic Local: Irritant 2; Allergen 1
Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Toxicology: It is primarily a skin irritant. However, it can cause systemic poisoning by acting both as a blood and nerve poison. It may also cause injury to the eyes and dermatitis, particularly to those who are sensitive to it. Such individuals are affected by even very slight traces of it. In a suitable solvent, this material can readily be absorbed through human skin, and can cause local hyperemia, itching, dermatitis, edema, and corrosion associated with enlargement of regional lymph glands as well as serious systemic disorders such as restlessness, methemoglobinemia, cyanosis, convulsions, tachycardia, dyspnea, and death. These same symptoms can be induced by ingestion of the material. For poisoning treat symptomatically.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

RHENIUM
Description: Hexagonal, metallic, lustrous crystal.
Formula: Re
Constants:
At. Wt. 186.31
M. P. 3167 ± 60°C
Density 20.53
Toxicity: Unknown
Radiation Hazard (Section 5): Artificial isotope Re^{183}, half-life: 240 days; emits gamma rays of 0.08, 0.25 or 1.0 mev. The permissible levels are: In body: 35 microcuries; in air: 8×10^{-6} microcurie per milliliter; in water: 8×10^{-2} microcurie per milliliter. The permissible levels shown are for the thyroid as the critical organ. If the skin is considered the critical organ, the permissible levels are somewhat higher.

Natural isotope Re^{187}, half-life: 4×10^{12} years; emits beta particles of 0.043 mev. This isotope occurs at a concentration of about 63%. The weak beta radiation is only a very slight hazard, even internally.
Fire Hazard: Moderate in the form of dust, when exposed to heat or

flame (Section 6).
Storage and Handling: Section 7

RHENIUM DISULFIDE
Description: Black, hexagonal leaf.
Formula: ReS_2
Constants:
Mol. Wt. 250.44
B. P. Decomp.
Density 7.5
For other properties, see Sulfides.

RHENIUM HEPTASULFIDE
Description: Black crystals.
Formula: Re_2S_7
Constants:
Mol. Wt. 597.1
B. P. Decomposes
Density 4.87 @24.5°C
For other properties, see Sulfides.

RHENIUM HEXAFLUORIDE
Description: Pale yellow crystals.
Formula: ReF_6
Constants:
Mol. Wt. 300.31
M. P. 25.6°C
B. P. 47.6°C
Density Liquid: 6.1573; Solid: 4.251
Toxicity: Highly toxic. See Fluorides.
Disaster Control: Dangerous. See Fluorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

RHENIUM OXYTETRAFLUORIDE
Description: Colorless crystals.
Formula: $ReOF_4$
Constants:
Mol. Wt. 278.31
M. P. 39.7°C
B. P. 62.7°C
Density Liquid: 5.314; Solid: 4.032
Toxicity: Highly toxic. See Fluorides.
Disaster Control: Dangerous. See Fluorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

RHENIUM TETRAFLUORIDE
Description: White solid.
Formula: ReF_4
Constants:
Mol. Wt. 262.31
M. P. 124.5°C
For other properties, see Fluorides.

RHENIUM TRIOXYBROMIDE
Description: White crystals.
Formula: ReO_3Br
Constants:
Mol. Wt. 314.23
M. P. 39.5°C
B. P. 163°C
For other properties, see Bromides.

RHIGOLENE. See Pentane and Isopentane.

RHODANINE
Synonym: 2-Thio-4-keto-thiazolidine.
Description: Yellow crystals.
Formula: $C_3H_3ONS_2$
Constants: Mol. Wt. 133.1
M. P. 166°C (decomp.)
Density 0.868
Toxicity: Details unknown. See also Thiocyanates.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

RHODIUM
Description: Cubic gray-white crystals.
Formula: Rh
Constants:
Mol. Wt. 102.9
M. P. 1985°C
B. P. > 2500°C
Density 12.4
Toxicity: Unknown
Radiation Hazard (Section 5): Artificial isotope Rh^{103}, half-life: 57 minutes; emits electron particles of 0.03 mev. The permissible levels are: In body: 6 microcuries; in air: 7×10^{-7} microcurie per milliliter; in water: 1×10^{-2} microcurie per milliliter. Rh^{103} exists in equilibrium with its parent, Ru^{103}. The hazard rating and permissible levels are given for the equilibrium mixture. Hazard Rating,

Class II (National Bureau of Standards Handbook No. 42).

Artificial isotope Rh^{105}, half-life: 36.5 hours; emits gamma rays of 0.33 mev and beta particles of 0.6 mev. The permissible levels are: In body: 9 microcuries; in air: 10^{-6} microcurie per milliliter; in water: 1.5×10^{-2} microcurie per milliliter.

Artificial isotope Rh^{106}, half-life: 30 seconds; emits beta particles of 2.3 mev (18%) and 3.55 mev (82%) and gamma rays of 0.51, 0.8, and 1.3 mev. The permissible levels are: In body: 4 microcuries; in air: 3×10^{-8} microcurie per milliliter; in water: 0.1 microcurie per milliliter.

Rh^{106} exists in equilibrium with its parent, Ru^{106}. The hazard rating and permissible levels are given for the equilibrium mixture.

Fire Hazard: Moderate, when exposed to heat or flame (Section 6).

Storage and Handling: Section 7

RHODIUM HYDROSULFIDE

Description: Black crystals.
Formula: $Rh(HS)_3$
Constants:
Mol. Wt. 202.13
M. P. Decomposes
For other properties, see Sulfides.

RHODIUM MONOSULFIDE

Description: Gray-black crystals.
Formula: RhS
Constants:
Mol. Wt. 134.98
M. P. Decomposes
For other properties, see Sulfides.

RHODIUM NITRATE

Description: Brown-yellow crystals.
Formula: $Rh(NO_3)_3$
Constants: Mol. Wt. 288.9
M. P. Decomposes
For other properties, see Nitrates.

RHODIUM SESQUISULFIDE

Description: Black crystals.
Formula: Rh_2S_3
Constants:
Mol. Wt. 302.02
M. P. Decomposes
For other properties, see Sulfides.

RHODIUM SULFITE

Description: Yellow crystals.
Formula: $Rh_2(SO_3)_3 \cdot 6H_2O$
Constants:
Mol. Wt. 544.11
M. P. Decomposes
For other properties, see Sulfites.

RHODIUM TRIFLUORIDE

Description: Rhombic, red crystals.
Formula: RhF_3
Constants:
Mol. Wt. 159.91
B. P. > 600°C sublimes
Density 5.38
For other properties, see Fluorides.

RICHE GAS. See Carbon Monoxide.

RICIN

Synonym: Agglutinin.
Description: White powder.
Toxic Hazard Rating:
Acute Local: Ingestion 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: 0
Chronic Systemic: Ingestion 2; Inhalation 2

Toxicology: Causes violent purging which may lead to collapse and death. Small particle in eye, nose or any skin abrasion may prove fatal. May cause destruction of red blood cells.

Disaster Control: Dangerous; when heated, it emits highly toxic fumes.

Personal Hygiene Section 3
Storage and Handling: Section 7

RICININE

Synonym: 1,2-Dihydro-4-methoxy-1-methyl-2-oxonicotino-nitrile.
Description: Alkaloid from castor bean plant.
Formula: $C_8H_8N_2O_2$
Constants:
Mol. Wt. 164.2
M. P. 201.5°C,
Sublimes @170 - 180°C @20 mm
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when

heated to decomposition, it emits highly toxic fumes of cyanide.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ROCKET AMMUNITION. See Explosives, High.
Shipping Regulations: Section 11.
Coast Guard - Several Classifications.

ROHRBACH'S SOLUTION. See Mercuric Barium Iodide.

ROSIN
Synonyms: Gum rosin; colophony; piece resin.
Constants:
M. P. 100 - 150°C
Flash P. 370°F (C.C.)
Density 1.08
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; when exposed to heat or flame, it emits acrid fumes; can react with oxidizing materials (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Hazardous article.

"ROSINAMINE-D"
Synonym: Dehydroabietyl amine.
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

ROSIN OIL
Synonym: Retinol.
Description: An oil.
Constants:
B. P. > -7280°C
Flash P. 266°F (C.C.)
Density 0.98
Autoign. Temp. 648°F
Toxicity: Unknown
Fire Hazard: Slight; when exposed to heat or flame.
Spontaneous Heating: Yes
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

ROTENONE
Synonym: Tubatoxin.
Description: White, odorless crystals derived from derris root.
Formula: $C_{23}H_{22}O_6$
Constants:
Mol. Wt. 394.4
M. P. 163°C
Density 1.27 @20°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

ROUGH AMMONIATE TANKAGES
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame; can react vigorously with oxidizing materials (Section 6).
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

RUBBER CEMENT. See Cement, Rubber.

RUBBER, CRUDE
Synonyms: India rubber, caoutchouc.
Description: Light cream to dark amber, amorphous, elastic, dry loaves, sheets or slabs.
Constant:
Density About 0.9
Toxicity: None
Fire Hazard: Very slight, but will

support combustion; when exposed to flame (Section 6); it emits dense, acrid smoke.

RUBBER, CURED
Toxicity: Cured rubber products may have slight toxicity or cause superficial dermatitis due to the active vulcanizing agents used, for example, sulfur, diphenylguanidine, phenyl-β-naphthylamine, mercaptobenzothiazole and its derivatives. The rubber itself is not toxic.
Fire Hazard: Slight, when exposed to flame. In the form of dust or fine particles, hard rubber is a more serious hazard, and should be kept away from sparks and open flame (Section 6).
Disaster Control: Dangerous in the form of dust. In burning it will emit toxic fumes of sulfides.
Shipping Regulations: None

RUBBER LATEX. See Latex, Rubber.

RUBBER, RECLAIMED
Toxicity: Slight. A weak allergen.
Fire Hazard: Dangerous, when exposed to flame; it emits acrid and toxic fumes of sulfides when burning.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

RUBBER SCRAP OR BUFFINGS
Toxicity: None
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Moderate, in the form of dust when exposed to flame.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of sulfides.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

RUBIDIUM
Description: Soft, silvery-white metal.
Formula: Rb
Constants:
At. Wt. 85.48
M. P. 38.5°C
B. P. 700°C
Density 1.532; Liquid 1.475 @ 38.5°C
Vap. Press. 1 mm @297°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2
Chronic Local: U
Chronic Systemic: Ingestion 1
Radiation Hazard (Section 5): Artificial isotope Rb^{86}, half-life: 19.5 days; emits beta particles of 0.7 mev (20%) and 1.8 mev (80%) and gamma rays of 1.1 mev. The permissible levels are: In body: 60 microcuries; in air: 4×10^{-7} microcurie per milliliter; in water: 3×10^{-3} microcurie per milliliter.

Natural isotope Rb^{87}, half-life: 6×10^{10} years; emits beta particles of 0.56 mev and gamma rays between 0.03-0.13 mev. This isotope occurs at a concentration of about 27%.
Fire Hazard: Dangerous, when exposed to heat or flame or by chemical reaction with oxidizers. See also Sodium (Section 6).
Explosion Hazard: Moderate; reacts explosively with moisture, acids and oxidizers. See also Sodium and NaK.
Disaster Control: Dangerous; when heated, it emits toxic fumes of rubidium oxide; will react with water or steam to produce hydrogen and flammable vapors; reacts vigorously with oxidizing materials.
Storage and Handling: Section 7

RUBIDIUM BROMATE
Formula: $RbBrO_3$
Constants:
Mol. Wt. 213.40
M. P. 430°C
Density 3.68
For other properties, see Bromates.

RUBIDIUM BROMOCHLOROIODIDE
Description: Rhombic crystals.

Formula: RbIBrCl
Constants:
Mol. Wt. 327.8
M. P. 205°C
B. P. Decomp. @200°C
For other properties, see Bromides and Iodides.

RUBIDIUM CARBONATE
Description: White, deliquescent powder.
Formula: Rb_2CO_3
Constants:
Mol. Wt. 230.97
M. P. 837°C
B. P. Decomp.
Toxicity: See Potassium Carbonate.

RUBIDIUM CHLORATE
Description: Crystals.
Formula: $RbClO_3$
Constants:
Mol. Wt. 168.94
Density 3.19
For other properties, see Chlorates.

RUBIDIUM CHLOROPLATINATE
Description: Cubic, yellow crystals.
Formula: Rb_2PtCl_6
Constants:
Mol. Wt. 578.93
M. P. Decomposes
Density 3.94 @17.5°C
Toxicity: See Platinum Compounds.
Disaster Control: See Chlorides.
Storage and Handling: Section 7

RUBIDIUM CHROMATE
Description: Yellow crystals.
Formula: Rb_2CrO_4
Constants:
Mol. Wt. 286.97
Density 3.518
Toxicity: See Chromium Compounds.
Fire Hazard: Moderate, by chemical reaction with reducing agents (Section 6).
Storage and Handling: Section 7

RUBIDIUM CHROMIUM SULFATE
Description: Cubic, violent crystals.
Formula: $RbCr(SO_4)_2 \cdot 12H_2O$
Constants:
Mol. Wt. 545.81
M. P. 107°C
Density 1.946
Toxicity: See Chromium Compounds.

RUBIDIUM COPPER SULFATE
Description: Monoclinic crystals.
Formula: $Rb_2SO_4 \cdot CuSO_4 \cdot 6H_2O$
Constants:
Mol. Wt. 534.73
Density 2.57
Toxicity: See Copper Compounds.

RUBIDIUM DICHROMATE
Description: Triclinic or monoclinic crystals.
Formula: $Rb_2Cr_2O_7$
Constants:
Mol. Wt. 386.98
B. P. Tricl.
Density 3.02 - 3.13
Toxicity: See Chromium Compounds.
Fire Hazard: Moderate, by chemical reaction with reducing agents.
Storage and Handling: Section 7

RUBIDIUM DISULFIDE
Description: Dark red crystals.
Formula: Rb_2S_2
Constants:
Mol. Wt. 235.09
B. P. Volat. > 850°C
M. P. 420°C
For other properties, see Sulfides.

RUBIDIUM FLUORIDE
Description: Colorless crystals.
Formula: RbF
Constants:
Mol. Wt. 104.48
M. P. 760°C
B. P. 1410°C
Density Liquid: 2.88 @820°C
Vap. Press. 1 mm @921°C
For other properties, see Fluorides.

RUBIDIUM FLUOSILICATE
Description: Cubic crystals.
Formula: Rb_2SiF_6
Constants:
Mol. Wt. 313.02
Density 3.332
Toxicity: See Fluosilicates.
Disaster Control: See Fluosilicates.

RUBIDIUM FLUOSULFONATE
Description: Needles.
Formula: $RbFSO_3$
Constants:
Mol. Wt. 184.55
M. P. 304°C
Toxicity: See Fluosulfonates.

Disaster Control: See Fluosulfonates.
Storage and Handling: Section 7

RUBIDIUM GALLIUM SULFATE

Description: Colorless crystals.
Formula: $RbGa(SO_4)_2 \cdot 12H_2O$
Constants:
Mol. Wt. 563.52
Density 1.962
Toxicity: See Gallium Compounds.

RUBIDIUM HEXASULFIDE

Description: Brown-red crystals.
Formula: Rb_2S_6
Constants:
Mol. Wt. 363.36
M. P. 201°C
For other properties, see Sulfides.

RUBIDIUM HYDRIDE

Description: Colorless needles.
Formula: RbH
Constants:
Mol. Wt. 86.49
M. P. Decomposes @300°C
Density 2.0
For other properties, see Hydrides.

RUBIDIUM HYDROGEN NITRATE

Description: Tetragonal crystals.
Formula: $RbNO_3 \cdot HNO_3$
Constants:
Mol. Wt. 210.50
M. P. 62°C
For other properties, see Nitrates.

RUBIDIUM HYDROXIDE

Synonym: Rubidium hydrate.
Description: Grayish-white, deliquescent mass; strong base.
Formula: RbOH
Constants:
Mol. Wt. 102.49
M. P. 300°C
Density 3.203 @11°C
Toxicity: See Potassium Hydroxide.

RUBIDIUM IODATE

Description: Cubic crystals.
Formula: $RbIO_3$
Constants:
Mol. Wt. 260.40
M. P. Decomposes
Density 4.33 @19.5°C
For other properties, see Iodates.

RUBIDIUM IODIDE

Description: Colorless crystals.
Formula: RbI
Constants:
Mol. Wt. 212.40
M. P. 642°C
B. P. 1300°C
Density 3.55; Liquid: 2.87 @ 825°C
Vap. Press. 1 mm @748°C
For other properties, see Iodides.

RUBIDIUM MONOSULFIDE

Description: Colorless crystals.
Formula: Rb_2S
Constants:
Mol. Wt. 203.03
M. P. 530°C Decomposes
Density 2.912
For other properties, see Sulfides.

RUBIDIUM MONOXIDE

Description: Cubic, colorless-yellow crystals.
Formula: Rb_2O
Constants:
Mol. Wt. 186.96
M. P. Decomposes @400°C
Density 3.72
Toxicity: See Potassium Oxide.

RUBIDIUM NITRATE

Description: Hexagonal, cubic, rhombic or triclinic crystals.
Formula: $RbNO_3$
Constants:
Mol. Wt. 147.49
M. P. 310°C
Density 3.11; Liquid: 2.395 @ 400°C
For other properties, see Nitrates.

RUBIDIUM PENTASULFIDE

Description: Rhombic, red, deliquescent crystals.
Formula: Rb_2S_5
Constants:
Mol. Wt. 331.29
M. P. 225°C
Density 2.618 @15°C
For other properties, see Sulfides.

RUBIDIUM PERCHLORATE

Description: Rhombic crystals.
Formula: $RbClO_4$
Constants: Mol. Wt. 184.94
M. P. Fuses
B. P. Decomposes
Density 2.9
For other properties, see Perchlorates.

RUBIDIUM m-PERIODATE
Description: Tetragonal crystals.
Formula: $RbIO_4$
Constants:
  Mol. Wt. 276.40
  Density 3.918 @16°C
For other properties, see Iodates.

RUBIDIUM PERMANGANATE
Description: Crystals.
Formula: $RbMnO_4$
Constants:
  Mol. Wt. 204.41
  Density 3.235 @10.4°C
Toxicity: See Manganese Compounds.
Fire Hazard: Moderate, by chemical reaction with reducing agents (Section 6). An oxidizing agent; keep away from flammable materials.
Storage and Handling: Section 7

RUBIDIUM PEROXIDE
Description: Yellow crystals.
Formula: Rb_2O_2
Constants:
  Mol. Wt. 202.96
  M. P. 600°C
  Density 3.65 @0°C
For other properties, see Peroxides, Inorganic.

RUBIDIUM PRASEODYMIUM NITRATE
Description: Greenish, hygroscopic needles.
Formula: $2RbNO_3 \cdot Pr(NO_3)_3 \cdot 4H_2O$
Constants:
  Mol. Wt. 693.98
  M. P. 63.5; $-4H_2O$ @60°C
  Density 2.50
For other properties, see Nitrates.

RUBIDIUM SELENATE
Description: Colorless, rhombic crystals.
Formula: Rb_2SeO_4
Constants:
  Mol. Wt. 313.92
  Density 3.90
Toxicity: Highly toxic. See Selenium Compounds.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

RUBIDIUM SUPEROXIDE
Description: Yellow crystals.
Formula: RbO_2
Constants:
  Mol. Wt. 117.48
  M. P. 280°C
  Density 3.05 @0°C
For other properties, see Peroxides, Inorganic.

RUBIDIUM TRIBROMIDE
Description: Rhombic crystals.
Formula: $RbBr_3$
Constants:
  Mol. Wt. 325.23
  M. P. Decomp. @140°C
Toxicity: See Bromides.
Disaster Control: See Bromides.
Storage and Handling: Section 7

RUBIDIUM TRIIODIDE
Description: Rhombic, black crystals.
Formula: RbI_3
Constants:
  Mol. Wt. 466.24
  M. P. 190°C
  Density 4.03
Toxicity: See Iodides.
Disaster Control: See Iodides.
Storage and Handling: Section 7

RUBIDIUM TRISULFIDE
Description: Reddish-yellow crystals.
Formula: Rb_2S_3
Constants:
  Mol. Wt. 267.16
  M. P. 213°C
For other properties, see Sulfides.

RUM, DENATURED
Constant:
  Flash P. 77°F (C.C.)
Toxicity: Details unknown. See Ethyl Alcohol.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Inflammable liquid; red label.

RUTHENIUM

Description: I: Black, porous metal. II: Silvery-white, nonductile metal of the platinum group.

Formula: Ru

Constants:
At. Wt. 101.70
Density I: 8.6; II: 12.06
M. P. I: Above 1950°C; II: 2450°C
B. P. II: 4150°C

Toxicity: See Ruthenium Compounds.

Radiation Hazard (Section 5): Artificial isotope Ru^{103}, half-life: 40 days; emits beta particles of 0.2 and 0.8 mev and gamma rays of 0.24 and 0.56 mev. The permissible levels are: In body: 6 microcuries; in air: 7×10^{-7} microcurie per milliliter; in water: 1×10^{-2} microcurie per milliliter. Ru^{103} exists in equilibrium with its daughter Rh^{103}. The permissible levels are given for this equilibrium mixture.

Artificial isotope Ru^{106}, half-life: 1 year; emits electron particles of 0.04 mev. The permissible levels are: In body: 4 microcuries; in air: 3×10^{-8} microcurie per milliliter; in water: 0.1 microcuries per milliliter. Ru^{106} exists in equilibrium with its daughter, Rh^{106}. The permissible levels are given for this equilibrium mixture.

Fire Hazard: Moderate, in the form of dust, when exposed to heat or flame (Section 6).

RUTHENIUM COMPOUNDS

Toxicity: Details unknown; probably toxic, but such small amounts are used industrially that it does not constitute a hazard. It resembles osmium in that when it is heated in air, it evolves fumes which are injurious to the eyes and lungs.

Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of ruthenium oxide.

Storage and Handling: Section 7

RUTHENIUM HYDROXIDE

Description: Black powder.

Formula: $Ru(OH)_3$

Constant:
Mol. Wt. 152.72

Toxicity: See Ruthenium Compounds.

Disaster Control: See Ruthenium Compounds.

Storage and Handling: Section 7

RUTHENIUM PENTAFLUORIDE

Description: Dark green crystals.

Formula: RuF_5

Constants:
Mol. Wt. 196.70
M. P. 101°C
B. P. 270°C
Density 2.963 @16.5°C

Toxicity: Highly toxic. See Fluorides.

Disaster Control: See Fluorides.

Storage and Handling: Section 7

RUTHENIUM SULFIDE

Synonym: Laurite.

Description: Cubic, gray-black crystals.

Formula: RuS_2

Constants: Mol. Wt. 165.83
Density 6.99

For other properties, see Sulfides.

RUTHENIUM TETROXIDE

Description: Yellow, volatile crystals; odor of ozone.

Formula: RuO_4

Constants:
Mol. Wt. 165.70
M. P. 25.5°C
B. P. Approx. 100°C decomp.
Density 3.29 @21°C

Toxic Hazard Rating:
Acute Local: Irritant 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U

Fire Hazard: Moderate, by chemical reaction with reducing agents (Section 6). A powerful oxidizing agent.

Disaster Control: See Ruthemium Compounds.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

RYANIA

Composition: Ground wool of Ryania Spociosa.

Toxicity: Details unknown; probably low. It is exempt from tolerance regulations of the Food and Drug Administration. Specific for European corn borer.

Fire Hazard: Moderate, when exposed to heat or flame (Section 6).

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SABADILLA SEED
Synonyms: Cevadilla; caustic barley.
Description: A powder.
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: U
Toxicology: Although sabadilla seed contains poisonous alkaloids, there is no tolerance restriction imposed by the Food and Drug Administration for its use as an insecticide.
Disaster Control: Dangerous; when heated, it emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

SACCHARIN
Synonyms: Saxin; benzosulfinide.
Description: Crystals or powder.
Formula: $C_7H_5NO_3S$
Constants: Mol. Wt. 183.2
  M. P. 228°C (decomp.)
  B. P. Sublimes
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 1
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur, oxides of nitrogen.
Personal Hygiene: Section 3
Storage and Handling: Section 7

SAFETY FUSES. See Explosives, High.
Shipping Regulations: Section 11.
  I. C. C. Classification : See Section 11, § 73.100 (o).
  Coast Guard Classification: Explosive C

SAFETY LAMP GASOLINE. See Gasoline.

SAFETY SQUIBS. See Explosives, High.
Shipping Regulations: Section 11.
  I. C. C. Classification: Explosive C.
  Coast Guard Classification: Explosive C.

SAFROLE
Synonyms: 1-Allyl-3,4-methylenedioxybenzene; shikimole.
Description: Colorless liquid or crystals.
Formula: $C_3H_5C_6H_3O_2CH_2$
Constants:
  Mol. Wt. 162.18
  M. P. 11°C
  B. P. 234.5°C
  Density 1.0960 @20°C
  Vap. Press. 1 mm @63.8°C
Toxic Hazard Rating:
  Acute Local: Irritant 3
  Acute Systemic: Ingestion 3
  Chronic Local: Irritant 2
  Chronic Systemic: U
Fire Hazard: Slight; when exposed to heat or flame, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

SALICYL ALDEHYDE
Synonyms: Salicylic aldehyde.
Description: Clear, colorless, oily liquid; burning taste.
Formula: C_6H_4OHCOH
Constants:
  Mol. Wt. 122.1
  B. P. 197°C
  Freezing P. 1°C
  Density 1.167 @20°/4°C
  Vap. Press. 1 mm @33.0°C
Toxicity: Details unknown; an auxiliary fumigant. See also Aldehydes.

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

SALICYLANILIDE

Description: White, odorless crystals.
Formula: $C_6H_5NHCOC_6H_4OH$
Constants: Mol. Wt. 213.2
M. P. 135°C
B. P. Decomposes
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of nitrogen oxides.
Storage and Handling: Section 7

SALICYLIC ACID

Synonym: o-Hydroxybenzoic acid.
Description: White needle crystals or powder; sweetish, afterward acrid taste.
Formula: HOC_6H_4COOH
Constants:
Mol. Wt. 138.12
M. P. 159°C
B. P. Sublimes @76°C
Flash P. 315°F
Density 1.443 @20°/4°C
Autoign. Temp. 1013°F
Vap. Press. 1 mm @113.7°C
Toxic Hazard Rating:
Acute Local: Ingestion 2
Acute Systemic: Ingestion 1
Chronic Local: U
Chronic Systemic: Ingestion 1; Inhalation 1
Toxicology: Symptoms of poisoning are nausea and vomiting, ringing in the ears, dizziness, headache, dullness, confusion, sweating, rapid pulse and breathing and sometimes skin eruptions. Symptoms disappear when exposure or administration of the drug is terminated.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

SALT BATHS (NITRATE OR NITRITE)

Toxicity: Details unknown. See also Nitrates.
Radiation Hazard: Unknown
Fire Hazard: Dangerous, by spontaneous chemical reaction. These baths are oxidizing in nature.
Explosion Hazard: Moderate, by chemical reaction, due to contamination by cyanides or easily oxidizable materials or when heated to over 1000°F.
Disaster Control: Highly dangerous; in molten form will react with water, steam or acids to produce heat, hydrogen, toxic and corrosive fumes; can react vigorously with reducing materials.

SALTPETER. See Potassium Nitrate.

SAMARIUM

Description: Hexagonal, gray-white, metallic crystalline element.
Formula: Sm
Constants:
At. Wt. 150.43
M. P. > 1300°C
Density 7.7
Toxicity: Unknown
Radiation Hazard (Section 5): Artificial isotope Sm^{151}, half-life unknown; emits beta particles of 0.75 mev. The permissible levels are: In body: 420 microcuries; in air: 10^{-8} microcurie per milliliter; in water: 0.2 microcurie per milliliter.
Natural isotope Sm^{152}, half-life: 2.5×10^{11} years; emits alpha particles of 2.0 mev. Sm^{152} is present to the extent of about 27% in natural samarium. No permissible levels have been set for the natural material.
Fire Hazard: Moderate, in the form of dust, when exposed to flame or by spontaneous chemical reaction with oxidizers. See also Powdered Metals (Section 6).

SAMARIUM BROMATE

Description: Hexagonal, yellow crystals.
Formula: $Sm(BrO_3)_3 \cdot 9H_2O$

Constants:
Mol. Wt. 696.32
M. P. 75°C; $-9H_2O$ @150°C
For other properties, see Bromates.

SAMARIUM BROMIDE
Description: Yellow deliquescent crystals.
Formula: $SmBr_3 \cdot 6H_2O$
Constants:
Mol. Wt. 498.27
Density 2.971 @22°C
Toxicity: See Bromides.

SAMARIUM CARBIDE
Description: Yellow, crystalline mass.
Formula: SmC_2
Constants:
Mol. Wt. 174.45
Density 5.86
Toxicity: Details unknown. Evolves acetylene on contact with moisture.
For other properties, see Carbides.

SAMARIUM DICHLORIDE
Description: Dark reddish-brown, crystalline mass.
Formula: $SmCl_2$
Constants:
Mol. Wt. 221.34
M. P. 740°C
Density 3.687 @22°C
Toxicity: See Hydrochloric Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of hydrochloric acid; will react with water or steam to produce hydrochloric acid.
Storage and Handling: Section 7

SAMARIUM IODIDE
Description: Orange-yellow crystals.
Formula: SmI_3
Constants:
Mol. Wt. 531.19
M. P. 816 - 824°C
B. P. Decomposes
Toxicity: See Iodides.

SAMARIUM NITRATE
Description: Triclinic, pale yellow crystals.
Formula: $Sm(NO_3)_3 \cdot 6H_2O$
Constants:
Mol. Wt. 444.55
M. P. 78 - 79°C
Density 2.375
For other properties, see Nitrates.

SAMARIUM OXALATE
Description: Crystals.
Formula: $Sm_2(C_2O_4)_3 \cdot 10H_2O$
Constant:
Mol. Wt. 745.08
Toxicity: Highly toxic. See Oxalates.

SAMARIUM SULFIDE
Description: Yellowish-pink crystals.
Formula: Sm_2S_3
Constants:
Mol. Wt. 397.06
M. P. 1900°C
Density 5.729
For other properties, see Sulfides.

SANTONIN
Synonym: Santonic lactone.
Description: Glossy, colorless crystals or white powder, turning yellow on exposure to light; odorless; tasteless at first, then bitter.
Formula: $C_{15}H_{18}O_3$
Constants:
Mol. Wt. 246.30
M. P. 170°C
B. P. Sublimes
Density 1.187
Toxic Hazard Rating:
Acute Local: Ingestion 1
Acute Systemic: Ingestion 2
Chronic Local: U
Chronic Systemic: U
Toxicology: It can cause disturbance of color vision. Objects first show bluish tinge, then yellow which is most prominent. Complete blindness may occur, lasting perhaps for nearly a week. Dizziness, drowsiness and nausea may also occur. Recovery is spontaneous.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

SAPONINS
Synonyms: Sapotoxins; sapoglycosides.
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3
Chronic Local: U

Chronic Systemic: Ingestion 3
Toxicology: Local irritation. When absorbed they may destroy the red blood cells and damage liver tissue.
Treatment and Antidotes: Wash out stomach if vomiting has not occurred. Other treatment is supportive and symptomatic.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

SARIN

Synonym: Fluoroisopropoxymethylphosphine oxide.
Description: Colorless liquid.
Formula:
$[(CH_3)_2CHO](CH_3)(F)(O)P$
Constants:
Mol. Wt. 140.1
B. P. 147°C
Freezing P. −38°C
Density 1.100 @20°C
Vap. Press. 1.57 mm @20°C
Vap. D. 4.86
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Toxicology: This is a nerve gas, acting much like tabun. Highly toxic to eyes. A small drop on skin will kill a man within 15 minutes. Liquid does not injure skin but penetrates it rapidly. See Hydrofluoric Acid.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Highly dangerous; when heated, it emits highly toxic fumes; will react with water or steam to produce toxic and corrosive fumes; can react with oxidizing materials.
Ventilation Control (use high rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

SAWDUST

Synonym: Wood dust.
Description: Yellowish particles of wood.
Toxic Hazard Rating:
Acute Local: Allergen 1; Inhalation 1
Acute Systemic: U
Chronic Local: Allergen 1; Inhalation 1
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Spontaneous Heating: Possible. Avoid hot, humid storage or contact with drying oils. Particularly dangerous if charred or partially burned.
Explosion Hazard: Slight, when exposed to flame.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Hazardous, when dry, clean and oil-free.

SCANDIUM

Synonym: Ekaboron.
Description: Silver crystals.
Formula: Sc
Constants:
At. Wt. 45.0
M. P. 1200°C
B. P. 2400°C
Density 2.5
Toxicity: Unknown
Radiation Hazard (Section 5): Artificial isotope Sc^{46}, half-life: 85 days; emits beta particles of 0.36 mev and gamma rays of 0.18, 0.89 and 1.2 mev. The permissible levels are: In body: 6 microcuries; in air: 7×10^{-8} microcurie per milliliter; in water 0.4 microcurie per milliliter.
Fire Hazard: Moderate, in the form of dust, when exposed to heat or flame or by chemical reaction with oxidizers. See also Powdered Metals (Section 6).

SCANDIUM BROMIDE

Description: Crystals.

Formula: $ScBr_3$
Constants:
Mol. Wt. 284.85
M. P. Sublimes > 1000°C
Density 3.914
Toxicity: Details unknown. See also Bromides.

SCANDIUM NITRATE

Description: Colorless crystals.
Formula: $Sc(NO_3)_3$
Constants:
Mol. Wt. 231.12
M. P. 150°C
For other properties, see Nitrates.

SCANDIUM OXALATE

Description: Crystals.
Formula: $Sc_2(C_2O_4)_3 \cdot 5H_2O$
Constants:
Mol. Wt. 444.34
M. P. $-4H_2O$ @140°C
Toxicity: Highly toxic. See Oxalates.

SCOPOLAMINE. See Hyoscine.

SEBACIC ACID

Synonym: Dodecane dioic acid.
Description: Thin, colorless crystals.
Formula: $COOH(CH_2)_8COOH$
Constants:
Mol. Wt. 202.3
M. P. 133°C
B. P. 295°C @100 mm
Vap. Press. 1 mm @183.0°C
Toxicity: Unknown
Storage and Handling: Section 7

SELENIC ACID

Description: Colorless, hexagonal prisms.
Formula: H_2SeO_4
Constants:
Mol. Wt. 144.98
M. P. 58°C
B. P. 260°C (decomp.)
Density Solid: 2.951 @15°C; Liquid: 2.609 @15°C
Toxicity: Highly toxic. See Selenium Compounds.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

SELENIOUS ACID

Description: Transparent, colorless crystals.
Formula: H_2SeO_3
Constants: Mol. Wt. 128.98
M. P. Decomposes
Density 3.004 @15°/4°C
Vap. Press. 2 mm @15°C
Toxicity: Highly toxic. See Selenium Compounds.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

SELENIUM

Description: Steel-gray, non-metallic element.
Formula: Se_8
Constants:
Mol. Wt. 631.68
M. P. 170 - 217°C
B. P. 690°C
Density 4.26 - 4.79
Vap. Press. 1 mm @356°C
Toxic Hazard Rating:
Acute Local: Ingestion 2; Inhalation 1
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3
MAC: ACGIH (accepted); 0.1 milligrams per cubic meter of air.
Toxicology: Selenium is a hazard in processing selenium-bearing products in glass decolorizing, in the production of ruby glass, of red and yellow glazes, of certain paints and pigments, of certain plastics, and of photoelectric apparatus; in the alloying of machineable stainless steel, of free-machining copper-base alloys, and in the fireproofing of electric cable. Its pathology has not as yet been adequately studied, although there are available considerable animal experimental data. However, it is known that there is a difference between its action on animals and on human beings.

In animals, subacute poisoning from selenium produces a pneumonia, fatty degeneration of the liver, degeneration of the kidney cells, and other alterations which clear up without residual pathology when the animals are removed from exposure. It has also caused cancer of the liver in rats. In human beings, gastrointestinal disturbances have been noted and it causes respiratory irritation, cough, edema of the lungs, vomiting, diarrhea, abdominal pain or cramps, loss of reflexes, cerebral irritation as manifested by convulsions, and ultimately death. It gives a garlic odor to the breath in acute stages.

This material resembles arsenic, both chemically and physiologically. It forms with hydrogen a hydrogen selenide which is an intensely toxic, flammable gas with a very offensive odor similar to that of rotten horseradish. 4 ppm of selenium is considered the outside tolerance limit in foodstuffs, and 3 ppm is considered a more reasonable limit. Small amounts of selenium getting into grain and herbage consumed by livestock in the western states has had disastrous effects, and a great deal has been written about it. In man, a concentration of 0.005 mg/liter is intolerable, producing eye and nasal irritation. Contact with metallic or amorphous selenium has not been reported as a source of skin injury, although selenium salts have given rise to a contact dermatitis. Guinea pigs exposed to 0.57 mg of hydrogen selenide per liter of air for 10 minutes died within 5 days, indicating that this material is highly toxic. 1.5 ppm of hydrogen selenide in the air in intolerable to man.

Fire Hazard: Moderate in the form of dust, when exposed to heat or flame or by chemical reaction with oxidizers. See also Powdered Metals.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

SELENIUM COMPOUNDS

Since selenium resembles arsenic chemically and physiologically, its compounds are all more than moderately toxic, hydrogen selenide is extremely toxic, and selenium salts often cause contact dermatitis. See Selenium for further discussion.

SELENIUM DIBUTYLDITHIOCARBAMATE

Description: Liquid.
Formula: $Se[SC(S)N(C_4H_9)_2]_4$
Constants:
Mol. Wt. 896.4
M. P. -25°C
Flash P. 225°F
Density 1.14 @20°/20°C
Vap. D. 30.9
Toxicity: Highly toxic. See Selenium Compounds.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous. See Selenium Compounds.
Storage and Handling: Section 7

SELENIUM DIETHYLDITHIOCARBAMATE

Description: Orange-yellow color.
Formula: $Se[SC(S)N(C_2H_5)_2]_4$
Constants:
Mol. Wt. 672.1
Density 1.32 @20°/20°C
Toxicity: Highly toxic. See Selenium Compounds.
Disaster Control: Dangerous. See Selenium Compounds.
Storage and Handling: Section 7

SELENIUM DIMETHYLDITHIOCARBAMATE

Description: Crystals.
Formula: $Se[SC(S)N(CH_3)_2]_4$
Constants: Mol. Wt. 559.9
M. Range: 63 - 71°C
Toxicity: Highly toxic. See Selenium Compounds.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

SELENIUM DIOXIDE

Description: White to slightly reddish, lustrous, crystalline powder or needles.
Formula; SeO_2
Constants:
Mol. Wt. 110.96
M. P. 340 - 350°C
B. P. Sublimes

Density 3.95 @15°/15°C
Vap. Press. 1 mm @157.0°C
Toxicity: Highly toxic. See Selenium Compounds.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

SELENIUM DISULFIDE

Description: Red-yellow crystals.
Formula: SeS_2
Constants: Mol. Wt. 143.09
M. P. < 100°C
B. P. Decomposes
Toxicity: Highly toxic. See Selenium Compounds and Sulfides.
For other properties, see Sulfides.

SELENIUM HEXAFLUORIDE

Description: Colorless gas.
Formula: SeF_6
Constants: Mol. Wt. 192.96
M. P. −39°C; sublimes @ −46.6°C
B. P. −34.5°C
Density 3.25 g/l @−25°C
Toxicity: Highly toxic. See Selenium Compounds and Fluorides.
Disaster Control: See Selenium Compounds and Fluorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

SELENIUM MONOBROMIDE

Description: Dark red liquid.
Formula: Se_2Br_2
Constants:
Mol. Wt. 317.75
B. P. 227°C (decomp.)
Density 3.604 @15°C
Toxicity: Highly toxic. See Selenium Compounds and Bromides.
Disaster Control: Dangerous. See Selenium Compounds and Bromides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

SELENIUM MONOBROMIDE TRICHLORIDE

Description: Yellow-brown crystals.
Formula: $SeBrCl_3$
Constants:
Mol. Wt. 265.25
M. P. 190°C
For other properties, see Selenium Compounds.

SELENIUM MONOCHLORIDE

Description: Brown-red liquid.
Formula: Se_2Cl_2
Constants:
Mol. Wt. 228.83
M. P. −85°C
B. P. 130°C (decomp.)
Density 2.91 @17°C; 2.77 @23°C
For other properties, see Selenium Compounds.

SELENIUM MONOSULFIDE

Description: Orange-yellow tablets or powder.
Formula: SeS
Constants:
Mol. Wt. 111.03
M. P. Decomposes @118 - 119°C
Density 3.056 @0°C
For other properties, see Selenium Compounds and Sulfides.

SELENIUM NITRIDE

Description: Amorphous orange-yellow to brick-red hygroscopic crystals.
Formula: Se_4N_4
Constants:
Mol. Wt. 371.87
M. P. Explodes @160 - 200°C
B. P. Decomposes
Toxicity: Highly toxic. See Selenium Compounds.
Explosion Hazard: Moderate, when exposed to heat.
Explosive Range: @160 - 200°C.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of selenium.
Storage and Handling: Section 7

SELENIUM OXYBROMIDE

Description: Red-yellow crystals.
Formula: $SeOBr_2$
Constants:
Mol. Wt. 254.79
M. P. 41.6°C
B. P. 217°C @740 mm (decomp.)
Density: Liquid: 3.38 @50°C
For other properties, see Selenium Compounds.

SELENIUM OXYCHLORIDE
Description: Colorless, yellowish liquid.
Formula: $SeOCl_2$
Constants:
Mol. Wt. 165.87
M. P. 8.5°C
B. P. 176.4°C
Density 2.42 @22°C
Vap. Press. 1 mm @34.8°C
For other properties, see Selenium Compounds.

SELENIUM OXYFLUORIDE
Description: Colorless liquid.
Formula: $SeOF_2$
Constants:
Mol. Wt. 132.96
M. P. 4.6°C
B. P. 124°C
Density 2.67
For other properties, see Selenium Compounds and Fluorides.

SELENIUM SULFIDE. See Selenium Monosulfide.

SELENIUM TETRABROMIDE
Description: Orange-red-brown crystals.
Formula: $SeBr_4$
Constants:
Mol. Wt. 398.62
M. P. Decomposes @75°C
For other properties, see Selenium Compounds and Bromides.

SELENIUM TETRACHLORIDE
Description: Cubic, white-yellow, deliquescent crystals.
Formula: $SeCl_4$
Constants:
Mol. Wt. 220.79
M. P. 305°C; sublimes @170 - 196°C
B. P. Decomposes @288°C
Density 3.78
Vap. Press. 1 mm @74.0°C
For other properties, see Selenium Compounds and Chlorides.

SELENIUM TETRAFLUORIDE
Description: Colorless liquid or white crystals.
Formula: SeF_4
Constants:
Mol. Wt. 154.96
M. P. −13.5°C
B. P. 93°C
For other properties, see Selenium Compounds and Fluorides.

SELENIUM TRIOXIDE
Description: Amorphous, pale yellow, hygroscopic solid.
Formula: SeO_3
Constants:
Mol. Wt. 126.96
M. P. Decomposes @120°C
Density 3.6
For other properties, see Selenium Compounds.

SESAMIN
Description: Crystals.
Formula: $C_{20}H_{18}O_6$
Constant:
Mol. Wt. 354.3
Toxicity: Details unknown; a fungicide.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Storage and Handling: Section 7

SHALE OIL
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: Irritant 3
Chronic Systemic: Inhalation 3
Disaster Control: Dangerous; when exposed to heat or flame, it emits acrid fumes.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

SHELLAC, LIQUID
Constant:
Flash P. 40 - 70°F
Toxicity: Details unknown. May act as an allergen.
Fire Hazard: Dangerous, when exposed to heat or flame. See also Ethyl Alcohol, the usual solvent.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: See Ethyl Alcohol.
Disaster Control: See Ethyl Alcohol.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Combustible liquid; inflammable liquid; red label.

SIGNAL OIL

Synonym: mineral seal oil.
Description: Viscid liquid.
Constant:
Flash P. 170 - 200°F
Toxicity: Unknown.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

SILANES

Synonyms: Silicon hydride, disilane.
Description: Gas or liquid.
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Dangerous, by chemical reaction with oxidizers; often ignite spontaneously in air (Section 6).
Explosion Hazard: Variable
Disaster Control: Dangerous; when heated, they can burn or explode and emit highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

SILICA

Synonyms: Silicon dioxide; silicic anhydride; cristobalite.
Description: Colorless crystals.
Formula: SiO_2
Constants:
Mol. Wt. 60.09
M. P. 1710°C
B. P. 2230°C
Density Amorphous 2.2; crystalline 2.6
Vap. Press. 10 mm @1732°C
Toxic Hazard Rating:
Acute Local: Inhalation 2
Acute Systemic: 0
Chronic Local: Inhalation 3
Chronic Systemic: Inhalation 1
Toxicology: From the point of view of numbers of men exposed and cases of disability produced, silica is the chief cause of pulmonary dust disease. The prolonged inhalation of dusts containing free silica may result in the development of a disabling pulmonary fibrosis known as silicosis. The Committee on Pneumoconiosis of the American Public Health Association defines silicosis as "a disease due to the breathing of air containing silica (SiO_2), characterized by generalized fibrotic changes and the development of miliary nodules in both lungs, and clinically by shortness of breath, decreased chest expansion, lessened capacity for work, absence of fever, increased susceptibility to tuberculosis (some or all of which symptoms may be present), and characteristic x-ray findings."

Silica occurs in the pure state in nature as quartz. It is the main constituent of sand, sandstone, tripoli and diatomaceous earth, and is present in high amounts (up to 35% in granite. Exposure to silica occurs in hard rock mining, in foundries, in manufacture of porcelain and pottery, in the spraying of vitreous enamels, in sandblasting, in granite-cutting and tombstone-making, in the manufacture of silica firebrick and other refractories, in grinding and polishing operations where natural abrasive wheels are used and other occupations.

The duration of exposure which is associated with the development of silicosis varies widely for different occupations. Thus, the average duration of exposure required for the development of silicosis in sand-blasters is 2 to 10 years, in moulders and granite cutters, about 30 years, and in hard rock miners 10 to 15 years. There is, also, much variation in individual susceptibility, certain workers showing radiological evidence of the disease years before their fellow workmen who are similarly exposed. Such susceptible individuals are fortunately rather rare.

The action of silica on the lungs results in the production of a diffuse, nodular fibrosis in which the parenchyma and the lymphatic system are involved. This fibrosis is, to a certain extent, progressive, and may continue to increase for several years after exposure is terminated. Where the pulmonary reserve is sufficiently reduced, the worker complains of shortness of breath on exertion. This is the first and most common symptom in cases of uncomplicated silicosis. If severe, it may incapacitate the worker for heavy, or even light, physical exertion, and in extreme cases there may be shortness of breath even while at rest. The most common physical sign of silicosis is a limitation of expansion of the chest. There may be a dry cough, sometimes very troublesome. The characteristic radiographic appearance is one of diffuse, discrete nodulation, scattered throughout both lung fields. Where the disease advances, the shortness of breath becomes worse, and the cough more productive and troublesome. There is no fever or other evidence of systemic reaction. Further progress of the disease results in marked fatigue, extreme dyspnea and cyanosis, loss of appetite, pleuritic pain and total incapacity to work. If tuberculosis does not supervene, the condition may eventually cause death either from cardiac failure or from destruction of lung tissue, with resultant anoxemia. In the later stages, the x-ray may show large, conglomerate shadows, due to the coalescence of the silicotic nodules, with areas of emphysema between them.

Ventilation Control (use moderate rate): Section 2

SILICA GEL

Synonym: Silicic acid (precipitated).
Description: White powder or lustrous granules.
Formula: H_2SiO_3
Constant:
Mol. Wt. 78.1
Toxicity: Slight. See Silica.

SILICATES

Toxicity: Soluble alkaline silicates act locally like mild alkalies. The dust of certain silicates such as asbestos (hydrated magnesium silicate) and talc can produce fibrotic changes in the lungs.

SILICIDES OF LIGHT METALS

Description: Metallic, crystalline materials.
Toxicity: Variable.
Fire Hazard: Moderate, by chemical reaction. See also Hydrogen (Section 6).
Explosion Hazard: Moderate, by chemical reaction. See also Hydrogen.
Disaster Control: Moderately dangerous; they will react with water or steam to produce hydrogen; on contact with acid or acid fumes, they can emit toxic fumes.
Storage and Handling: Section 7

SILICOFLUORIDES. See Fluosilicates.

SILICON

Description: Cubic, steel-gray crystals or dark brown powder.
Formula: Si
Constants:
At. Wt. 28.09
M. P. 1420°C
B. P. 2600°C
Density 2.42 or 2.3 @20°C
Vap. Press. 1 mm @1724°C
Toxicity: Details unknown. See also Silica.
Fire Hazard: Moderate, when exposed to flame or by chemical reaction with oxidizers. See also Powdered Metals (Section 6).
Disaster Control: Dangerous; when heated, it will react with water or steam to produce hydrogen; can react with oxidizing materials.
Storage and Handling: Section 7

SILICON BROMIDE

Synonym: Tetrabromosilicane.
Description: Colorless, fuming liquid; disagreeable odor.
Formula: $SiBr_4$
Constants:
Mol. Wt. 347.72
M. P. 5°C

B. P. 153°C
Density 2.814
Vap. D. 2.82
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of hydrobromic acid; will react with water or steam to produce heat, toxic and corrosive fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

SILICON CARBIDE

Description: Bluish-black, iridescent crystals.
Formula: SiC
Constants:
Mol. Wt. 40.10
M. P. 2600°C
B. P. Sublimes above 2000°C; decomposes @2210°C
Density 3.17
Toxic Hazard Rating:
Acute Local: Inhalation 1
Acute Systemic: U
Chronic Local: Inhalation 1
Chronic Systemic: U
MAC: ACGIH (accepted); 50 million particles per cubic foot of air.

SILICON CHLORIDE

Synonym: Silicon tetrachloride.
Description: Colorless, fuming liquid; suffocating odor.
Formula: $SiCl_4$
Constants:
Mol. Wt. 169.89
M. P. -70°C
B. P. 57.57°C
Density 1.483
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of hydrochloric acid; will react with water or steam to produce heat, toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

SILICON DIBROMIDE SULFIDE

Description: Colorless plates.
Formula: $SiSBr_2$
Constants:
Mol. Wt. 219.95
M. P. 93°C
B. P. 150°C @18.3 mm
Toxic Hazard Rating:
Acute Local: Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3
For other properties, see Sulfides.

SILICON DICHLORIDE SULFIDE

Description: Colorless prisms.
Formula: $SiSCl_2$
Constants:
Mol. Wt. 131.04
M. P. 75°C
B. P. 92°C @22.5 mm
Toxic Hazard Rating:
Acute Local: Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3
For other properties, see Sulfides.

SILICON DIOXIDE. See Silica.

SILICON DISULFIDE

Description: White needles.
Formula: SiS_2
Constants:
Mol. Wt. 92.19
M. P. Sublimes
B. P. White heat
Toxic Hazard Rating:
Acute Local: Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U

Chronic Systemic: Ingestion 3; Inhalation 3
For other properties, see Sulfides.

SILICON FLUORIDE
Synonym: Silicon tetrafluoride.
Description: Colorless gas; suffocating odor.
Formula: SiF_4
Constants:
Mol. Wt. 104.06
M. P. −77°C
B. P. −65°C @181 mm
Density 4.69 g/liter
Toxicity: See Fluorides and Hydrofluoric Acid.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

SILICON MONOSULFIDE
Description: Yellow needles or black solid.
Formula: SiS
Constants:
Mol. Wt. 60.13
B. P. Sublimes, 940°C @20 mm
Density 1.853 @15°C
For other properties, see Sulfides.

SILICON OXYHYDRIDE
Description: White powder.
Formula: $(SiHO_{3}/_{2})_x$
Constant:
Density 1.6
For other properties, see Hydrides.

SILICON TETRAACETATE
Description: Hygroscopic crystals.
Formula: $Si(C_2H_3O_2)_4$
Constants:
Mol. Wt. 264.24
M. P. 110°C Sublimes
B. P. 148°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Personal Hygiene: Section 3

SILICON TETRABROMIDE
Synonym: Tetrabromosilane.
Description: Colorless, fuming liquid.
Formula: $SiBr_4$
Constants:
Mol. Wt. 347.72
M. P. 5°C
B. P. 153°C
Density 2.814
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous. See Hydrobromic Acid and Bromides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

SILICON TETRACHLORIDE. See Silicon Chloride.

SILICON TETRAFLUORIDE
Synonym: Tetrafluorosilane.
Description: Colorless gas.
Formula: SiF_4
Constants:
Mol. Wt. 104.06
M. P. −77°C
B. P. −65°C @181 mm
Density 4.67 g/l
Toxicity: Highly toxic. See Fluorides and Hydrofluoric Acid.
Disaster Control: Dangerous; shock can shatter the compressed gas container, releasing the contents; when heated to decomposition, it emits highly toxic fumes of fluorides; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

SILICON TETRAIODIDE
Synonym: Tetraiodosilane.
Description: Cubic, colorless crystals.
Formula: SiI_4
Constants:
Mol. Wt. 535.74
M. P. 120.5°C
B. P. 290°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U

Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of iodides; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

SILICON TETRATHIOCYANATE

Description: Small prisms.
Formula: $Si(SCN)_4$
Constants:
Mol. Wt. 260.40
M. P. 143.8°C
B. P. 314.2°C
Toxicity: Details unknown. See also Thiocyanates.
Disaster Control: See Thiocyanates.
Storage and Handling: Section 7

SILICON TRICHLORIDE HYDROSULFIDE

Description: Colorless liquid.
Formula: $SiCl_3HS$
Constants: Mol. Wt. 167.51
B. P. 96 - 100°C
Density 1.45
For other properties, see Sulfides.

SILICYL OXIDE

Synonym: Disiloxane.
Description: Colorless gas.
Formula: $(SiH_3)_2O$
Constants:
Mol. Wt. 78.17
M. P. -144°C
B. P. -15.2°C
Density 0.881 @-80°C
Toxicity: Unknown
Fire Hazard: Details unknown; probably quite flammable.

SILK DUST

Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: Inhalation 1
Chronic Local: Allergen 1; Inhalation 1
Chronic Systemic: Inhalation 1
MAC: ACGIH (accepted); 50 million particles per cubic foot of air.
Fire Hazard: Moderate, when exposed to flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Moderate, in the form of a dust cloud, when exposed to flame.
Personal Hygiene: Section 3
Storage and Handling: Section 7

SILVER

Synonym: Argentum.
Description: Soft, ductile and malleable, lustrous, white metal.
Formula: Ag
Constants:
At. Wt. 107.88
M. P. 960.5°C
B. P. 1950°C
Density 10.5
Vap. Press. 1 mm @1357°C
Toxicity: See Silver Compounds.
Radiation Hazard (Section 5): Artificial isotope Ag^{105}, half-life: 40 days; emits gamma rays of 0.43 mev. The permissible levels are: In body: 28 microcuries; in air: 10^{-5} microcurie per milliliter; in water: 2 microcuries per milliliter.

Artificial isotope Ag^{109}, half-life: 39.2 sec.; emits gamma rays of 0.088 mev. The permissible levels are: In body: 40 microcuries; in air: 7×10^{-8} microcurie per milliliter; in water: 7×10^{-2} microcurie per milliliter.

Ag^{109} exists in a radioactive and a stable form. The radioactive form occurs in equilibrium with its parent, Pd^{109} and also Cd^{109} (positron emission). The permissible levels are given for the equilibrium mixture.

Artificial isotope Ag^{110}, half-life: 276 days; emits beta particles of 0.087 mev (58%) and 0.53 mev (35%) and many gamma rays between 0.66 - 1.4 mev.

Artificial isotope Ag^{111}, half-life: 7.6 days; emits beta particles of 1.0 mev. The permissible levels are: In body: 36 microcuries; in air: 3×10^{-5} microcurie per milliliter; in water: 4 microcuries per milliliter.

Fire Hazard: Moderate, in the form of dust, when exposed to flame or by chemical reaction with oxidizers. See also Powdered Metals (Section 6).

SILVER ACETATE
Description: White plates.
Formula: $AgC_2H_3O_2$
Constants:
Mol. Wt. 166.92
M. P. Decomposes
Density 3.259 @15°C
Toxicity: See Silver Compounds.

SILVER ACETYLIDE
Description: White precipitate.
Formula: Ag_2C_2
Constants:
Mol. Wt. 239.78
M. P. Explodes
Toxicity: See Silver Compounds.
Fire Hazard: Unknown
Explosion Hazard: Severe, when shocked or exposed to heat.
Disaster Control: Dangerous; shock or heat will explode it.
Storage and Handling: Section 7

SILVER AMALGAMS
Description: Silvery liquid or solid.
Formula: Ag + Hg
Toxicity: Highly toxic. See Mercury Compounds, Inorganic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of Mercury.
Storage and Handling: Section 7

SILVER AMMONIUM COMPOUNDS
Toxicity: See Silver Compounds.
Explosion Hazard: Severe, when shocked, exposed to heat, or by chemical reaction.
Disaster Control: Dangerous; shock or heat will explode them.
Storage and Handling: Section 7

SILVER o-ARSENATE
Description: Cubic, dark red crystals.
Formula: Ag_3AsO_4
Constants:
Mol. Wt. 462.55
Density 6.657 @25°C
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

SILVER ARSENITE
Synonym: Silver orthoarsenite.
Description: Fine, yellow powder; sensitive to light.
Formula: Ag_3AsO_3
Constants:
Mol. Wt. 446.55
M. P. 150°C (decomp.)
Toxicity: Highly toxic. See Arsenic Compounds.
Storage and Handling: Section 7

SILVER ARSPHENAMINE
Synonyms: Silver diaminodihydroxyarsenobenzene; silver salvarsan, silver diarsenal.
Description: Brownish-black powder; contains approximately 20% arsenic, 15% silver.
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

SILVER AZIDE
Description: White prisms.
Formula: AgN_3
Constants:
Mol. Wt. 149.90
M. P. 2.50°C
Toxicity: See Silver Compounds and Azides.
Explosion Hazard: Severe, when shocked or exposed to heat.
Explosive Range: @521°F.
Disaster Control: Dangerous; shock or heat will explode it.
Storage and Handling: Section 7

SILVER BENZOATE
Description: White powder.
Formula: $AgC_7H_5O_2$
Constant:
Mol. Wt. 228.99
Toxicity: See Silver Compounds.

SILVER BROMATE
Description: White powder.
Formula: $AgBrO_3$
Constants:
Mol. Wt. 235.8
M. P. Decomposes
Density 5.206
Toxicity: See Silver Compounds and Bromates.
Fire Hazard: See Bromates.
Disaster Control: See Bromates.
Storage and Handling: Section 7

SILVER CARBONATE
Description: Yellow crystalline powder.
Formula: Ag_2CO_3

Constants:
  Mol. Wt. 275.8
  M. P. 218°C (decomp.)
  Density 6.077
Toxicity: See Silver Compounds.

SILVER CHLORATE
Description: Tetragonal, white crystals.
Formula: $AgClO_3$
Constants:
  Mol. Wt. 191.34
  M. P. 230°C
  B. P. Decomposes @270°C
  Density 4.430
Toxicity: See Silver Compounds and Chlorates.
For other properties, see Chlorates.

SILVER CHLORIDE
Description: White granular powder.
Formula: $AgCl$
Constants:
  Mol. Wt. 143.34
  M. P. 455°C
  B. P. 1550°C
  Density 5.561
  Vap. Press. 1 mm @912°C
Toxicity: See Silver Compounds.

SILVER CHROMATE
Description: Red crystals.
Formula: Ag_2CrO_4
Constants:
  Mol. Wt. 331.77
  Density 5.625
Toxicity: See Chromium Compounds and Silver Compounds.

SILVER COMPOUNDS
Toxicity: The absorption of silver compounds into the circulation and the subsequent deposition of the reduced silver in various tissues of the body may result in the production of a generalized greyish pigmentation of the skin and mucous membrances – a condition know as argyria. The introduction of fine particles of silver through breaks in the skin produces a local pigmentation at the site of the injury.

Generalized argyria, rarely seen at the present time, was not infrequent in the past. The condition developed slowly, usually after some 2 to 25 years of exposure. Pigmentation was noticeable first in conjunctivae, and later in the mucous membranes of the mouth and gums and in the skin. There were no constitutional symptoms, and no physical disability. Persons exhibiting the condition, and who subsequently died from unrelated disease, showed, on autopsy, a deposition of silver in the blood vessel walls, kidneys, testes, pituitary, choroid plexus, and mucous membrane of the nose, maxillary antra, trachea and bronchi. Once deposited, there is no known method by which the silver can be eliminated; the pigmentation is permanent.

SILVER CYANATE
Description: Colorless crystals.
Formula: $AgOCN$
Constants:
  Mol. Wt. 149.90
  M. P. Decomposes
  Density 4.00
Toxicity: Highly toxic. See Cyanates.
Disaster Control: See Cyanates.
Storage and Handling: Section 7

SILVER CYANIDE
Description: White, odorless, tasteless powder which darkens on exposure to light.
Formula: $AgCN$
Constants:
  Mol. Wt. 133.90
  M. P. 320°C (decomp.)
  Density 3.95
Toxicity: Highly toxic. See Cyanides.
Fire Hazard: See Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: See Section 11, §73.370
  Coast Guard Classification: Poison B; poison label.

SILVER DICHROMATE
Description: Red crystals.
Formula: $Ag_2Cr_2O_7$
Constants:
  Mol. Wt. 431.78
  M. P. Decomposes
  Density 4.770

Toxicity: See Chromium Compounds and Silver Compounds.

SILVER DIFLUORIDE
Description: Brown powder.
Formula: AgF_2
Constants:
  Mol. Wt. 145.88
  M. P. 690°C
  Density 4.57 - 4.78
For other properties, see Fluorides.

SILVER FLUOGALLATE
Description: Colorless crystals.
Formula: $Ag_3(GaF_6) \cdot 10H_2O$
Constants:
  Mol. Wt. 687.52
  Density 2.90
Toxicity: See Fluogallates and Silver Compounds.
Disaster Control: See Fluogallates.
Storage and Handling: Section 7

SILVER FLUORIDE
Description: Yellow, crystalline masses.
Formula: AgF
Constants:
  Mol. Wt. 126.88
  M. P. 435°C
  Density 5.852 @15.5°C
For other properties, see Fluorides.

SILVER FLUOSILICATE
Description: Colorless crystals or white, deliquescent powder.
Formula: $Ag_2SiF_6 \cdot 4H_2O$
Constants:
  Mol. Wt. 429.88
  M. P. < 100°C
  B. P. Decomposes
Toxicity: See Fluosilicates and Silver Compounds.
Disaster Control: See Fluosilicates.
Storage and Handling: Section 7

SILVER FULMINATE
Description: Small needles.
Formula: $Ag_2C_2N_2O_2$
Constants:
  Mol. Wt. 299,80
  M. P. Explodes
Toxicity: See Fulminates.
Fire Hazard: Unknown
Explosion Hazard: Severe, when shocked or exposed to heat. See also Explosives, High.
Disaster Control: Dangerous; shock or heat will explode it; when heated to decomposition, it emits highly toxic fumes.
Storage and Handling: Section 7

SILVER HYPONITRITE
Description: Yellow crystals.
Formula: $Ag_2N_2O_2$
Constants:
  Mol. Wt. 275.77
  M. P. Decomposes @110°C
  Density 5.75 @30°C
Toxicity: See Nitrites and Silver Compounds.
Fire Hazard: Unknown
Explosion Hazard: Moderate, when exposed to heat.
Explosive Range: @302°F.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react with reducing materials.
Storage and Handling: Section 7

SILVER HYPOPHOSPHITE
Description: White crystals.
Formula: AgH_2PO_2
Constant:
  Mol. Wt. 172.9
Toxicity: See Silver Compounds.
Fire Hazard: Unknown
Explosion Hazard: Moderate, when exposed to heat.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus.
Storage and Handling: Section 7

SILVER IODATE
Description: Rhombic, colorless crystals.
Formula: $AgIO_3$
Constants:
  M. P. > 200°C
  B. P. Decomposes
  Density 5.525
  Mol. Wt. 282.80
Toxicity: See Silver Compounds and Iodates.
Fire Hazard: See Iodates.
Disaster Control: See Iodates.
Storage and Handling: Section 7

SILVER IODIDE
Description: Pale yellow powder.
Formula: AgI
Constants:
  Mol. Wt. 234.8

M. P. 556°C
B. P. 1506°C
Density 5.675
Vap. Press. 1 mm @820°C
Toxicity: See Iodides and Silver Compounds.
Disaster Control: See Iodides.
Storage and Handling: Section 7

SILVER LACTATE

Description: White or slightly gray crystalline powder.
Formula: $AgC_3H_5O_3 \cdot H_2O$
Constant:
Mol. Wt. 214.97
Toxicity: See Silver Compounds.
Storage and Handling: Section 7

SILVER NITRATE

Description: Colorless, transparent, tabular, rhombic, odorless crystals, becoming gray or grayish-black on exposure to light in presence of organic matter; bitter, caustic, metallic taste.
Formula: $AgNO_3$
Constants:
Mol. Wt. 169.89
M. P. 212°C
B. P. 444°C (decomp.)
Density 4.352 @19°C
Toxicity: Moderate. A powerful caustic. See also Silver Compounds.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label.

SILVER NITRIDE

Description: Colorless solid.
Formula: Ag_3N
Constant:
Mol. Wt. 337.7
Toxicity: See Silver Compounds and Nitrides.
Explosion Hazard: Severe, when shocked or exposed to heat. See also Explosives, High.
Disaster Control: Dangerous; shock or heat will explode it.
Storage and Handling: Section 7

SILVER NITRITE

Description: Rhombic, white crystals.
Formula: $AgNO_2$
Constants:
Mol. Wt. 153.89
M. P. Decomposes @140°C
Density 4.453 @26°C
Toxicity: See Nitrites and Silver Compounds.
Fire Hazard: See Nitrites.
Disaster Control: See Nitrites.
Storage and Handling: Section 7

SILVER NITROPRUSSIDE

Description: Light pink crystals.
Formula: $Ag_2[FeNO(CN)_5]$
Constant:
Mol. Wt. 431.71
Toxicity: Highly toxic. See Hydrocyanic Acid.
Disaster Control: Dangerous; emits highly toxic fumes on heating.
Storage and Handling: Section 7

SILVER OXALATE

Description: Colorless crystals.
Formula: $Ag_2C_2O_4$
Constants:
Mol. Wt. 303.78
Density 5.029 @4°C
Toxicity: Highly toxic. See Oxalates.
Explosion Hazard: Moderate, when exposed to heat.
Explosive Range: @140°C.
Disaster Control: Dangerous; emits highly toxic fumes on heating and may explode.
Storage and Handling: Section 7

SILVER OXIDE

Description: Dark brown, odorless powder; metallic taste.
Formula: Ag_2O
Constants:
Mol. Wt. 231.76
M. P. Decomposes @300°C
Density 7.143 @16.6°C
Toxicity: See Silver Compounds.
Fire Hazard: Moderate, by chemical reaction; an oxidizing agent (Section 6).
Storage and Handling: Section 7

SILVER PERCHLORATE

Description: White, deliquescent crystals.
Formula: $AgClO_4$
Constants:
Mol. Wt. 207.34
M. P. Decomposes @486°C
Density 2.806 @25°C
For other properties, see Perchlorates.

SILVER PERMANGANATE
Description: Violet, crystalline powder.
Formula: $AgMnO_4$
Constants:
  Mol. Wt. 226.81
  M. P. Decomposes
Toxicity: See Silver Compounds and Manganese Compounds.
Fire Hazard: See Permanganates.
Disaster Control: See Permanganates.
Storage and Handling: Section 7

SILVER PHENOL SULFONATE
Synonym: Silver sulfocarbolate.
Description: White to faintly reddish crystals.
Formula: $AgC_6H_4SO_3OH$
Constant:
  Mol. Wt. 281.1
Toxicity: See Silver Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

SILVER PHOSPHATE
Description: Yellow powder.
Formula: Ag_3PO_4
Constants:
  Mol. Wt. 418.6
  M. P. 849°C
  Density 6.37
Toxicity: See Silver Compounds.
Disaster Control: See Phosphorus Compounds.
Storage and Handling: Section 7

SILVER PICRATE
Synonym: Picratol.
Description: Yellow crystals.
Formula: $C_6H_2O(NO_2)_3Ag \cdot H_2O$
Constant:
  Mol. Wt. 353.99
For other properties, see Nitrates.

SILVER-POTASSIUM CYANIDE
Description: White crystals; slight odor of HCN.
Formula: $KAg(CN)_2$
Constant:
  Mol. Wt. 199.00
For other properties, see Cyanides.

SILVER PROPARGYLATE
Description: Crystals.
Formula: $CHCCH_2Ag$
Constant:
  Mol. Wt. 147
Toxicity: See Silver Compounds.
Explosion Hazard: Moderate, when exposed to heat.
Storage and Handling: Section 7

SILVER SELENATE
Description: Crystals.
Formula: Ag_2SeO_4
Constants:
  Mol. Wt. 358.7
  Density 5.72
Toxicity: Highly toxic. See Selenium Compounds and Silver Compounds.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

SILVER SELENIDE
Description: Cubic, thin, gray plates.
Formula: Ag_2Se
Constants:
  Mol. Wt. 294.72
  M. P. 880°C
  B. P. Decomposes
  Density 8.0
Toxicity: Highly toxic. See Selenium Compounds and Silver Compounds.
Fire Hazard: See Selenium Compounds.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

SILVER SELENITE
Description: Needle-like crystals.
Formula: Ag_2SeO_3
Constants:
  Mol. Wt. 342.7
  Density 5.9297
Toxicity: Highly toxic. See Selenium Compounds and Silver Compounds.
Fire Hazard: Slight, by chemical reaction; evolves oxygen on decomposition (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of selenium; can react with reducing materials.
Storage and Handling: Section 7

SILVER SULFATE

Description: Rhombic, white crystals.
Formula: Ag_2SO_4
Constants:
Mol. Wt. 311.82
M. P. 652°C
B. P. Decomposes @1085°C
Density 5.45 @29.2°C
Toxicity: See Silver Compounds.

SILVER SULFIDE

Synonym: Acanthite.
Description: Rhombic, gray-black crystals.
Formula: Ag_2S
Constants:
Mol. Wt. 247.83
M. P. Tr. 175°C
B. P. Decomposes
Density 7.326
For other properties, see Sulfides.

SILVER SULFITE

Description: White crystals.
Formula: Ag_2SO_3
Constants:
Mol. Wt. 295.82
M. P. Decomposes @100°C
Toxicity: See Silver Compounds and Sulfites.
Disaster Control: See Sulfites.
Storage and Handling: Section 7

SILVER TETRAZOL

Description: Solid.
Formula: $AgCHN_4$
Constant:
Mol. Wt. 176.9
Toxicity: See Silver Compounds.
Explosion Hazard: Severe, when exposed to heat.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of nitrogen oxides and may explode.
Storage and Handling: Section 7

SILVER-THALLIUM NITRATE

Description: White, crystalline powder.
Formula: $AgNO_3 \cdot TlNO_3$
Constants:
Mol. Wt. 435.90
M. P. 75°C
Toxicity: See Thallium Compounds and Silver Compounds.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates and Thallium Compounds.
Storage and Handling: Section 7

SILVER THIOARSENITE

Synonym: Proustite.
Description: Crystals.
Formula: Ag_3AsS_3
Constants: Mol. Wt. 494.73
M. P. > 175°C
Density 5.49
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur and arsenic.
Storage and Handling: Section 7

SISAL

Toxic Hazard Rating:
Acute Local: Allergen 1; Inhalation 1
Acute Systemic: Inhalation 2
Chronic Local: Allergen 1; Inhalation 1
Chronic Systemic: Inhalation 1
MAC: ACGIH (accepted); 50 million particles per cubic foot of air.
Fire Hazard: Moderate, in the form of dust, when exposed to heat or flame; keep cool and dry; partially burned or charred material is dangerous (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

SLATE (below 5% free silica)

Description: A fine-grained green, black or red sedimentary rock.
Toxic Hazard Rating:
Acute Local: Inhalation 1
Acute Systemic: 0
Chronic Local: Inhalation 1
Chronic Systemic: 0
MAC: ACGIH (accepted); 50 million particles per cubic foot.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

SLUDGE ACID. See Sulfuric Acid.
Shipping Regulations: Section 11.
I.C.C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

SMOG

Description: An atmospheric combination of smoke, fog, and industrial gases.
Toxic Hazard Rating:
Acute Local: Inhalation 1
Acute Systemic: Inhalation 1
Chronic Local: Inhalation 1
Chronic Systemic: Inhalation 2
Composition: Contents vary, but sulfur dioxide is a common component. Other sulfides, fluorides, chlorides, carbon particles and various hydrocarbons may be found in smog. See Section 4.

SMOKELESS POWDER

Nitrocellulose containing about 13.1% nitrogen, produced by blending material of somewhat lower (12.6%) and slightly higher (13.2%) nitrogen content, converting to a dough with alcohol ether mixture, extruding, cutting and drying to a hard horny product. Small amounts of stabilizers (amines) and plasticizers are usually present, as well as various modifying agents (nitrotoluene, nitroglycerine salts). See also Nitrocellulose and Explosives, High.

SOAP POWDERS

Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1; Ingestion 1
Chronic Local: Irritant 1; Allergen 1
Chronic Systemic: U
Fire Hazard: Slight, by chemical reaction (Section 6).
Spontaneous Heating: Moderate
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

SOAPSTONE DUST

Synonyms: Talc dust; steatite.
Description: White to greenish-white crystals.
Formula: $3MgO \cdot 4SiO_2 \cdot H_2O$
Constants:
Mol. Wt. 379.3
Density 2.7 - 2.8
Toxic Hazard Rating:
Acute Local: Inhalation 1
Acute Systemic: 0
Chronic Local: Inhalation 1
Chronic Systemic: U
MAC: ACGIH (accepted); 20 million particles per cubic foot of air.
Ventilation Control (use normal rate): Section 2

SODIUM

Synonym: Natrium.
Description: Light, soft, ductile, malleable, silver-white metal.
Formula: Na
Constants: At. Wt. 23.0
M. P. 97.81°C
B. P. 892°C
Density 0.9710 @20°C
Autoign. Temp. Above 115°C in dry air.
Vap. Press. 1.2 mm @400°C
Toxic Hazard Rating:
Acute Local: (Metallic Na): Irritant 1; Ingestion 3; Inhalation 3. (Na Smoke): Irritant 2; Ingestion 3
Acute Systemic: U
Chronic Local: (Metallic Na): Irritant 1. (Na Smoke): Irritant 2
Chronic Systemic: U
Caution: Metallic sodium reacts exothermally with the moisture of body or tissue surfaces, causing thermal and chemical burns due to the reaction with sodium and the sodium hydroxide formed.
Radiation Hazard (Section 5): Artificial isotope Na^{22}, half-life: 2.6 years; emits gamma rays of 1.3 mev and positron particles of 0.58 mev. Radiation Hazard Rating, Class II (National Bureau of Standards Handbook No. 42).

Artificial isotope Na^{24}, half-life: 14.9 hours; emits beta particles of 1.4 mev and gamma rays of 1.38 and 2.76 mev. The permissible levels are: In body: 10^4 microcuries; in air: 2×10^{-5} microcurie per milliliter; in water; 0.2 microcuries per milliliter. Radiation Hazard Rating, Class I (National Bureau of Standards Handbook No. 42).
Fire Hazard: Dangerous, when exposed to heat or flame, or by chemical reaction with moisture, air, or any oxidizing material; decomposes moisture to evolve hydrogen and heat; reacts exothermally with the halogens, acids and halogenated hydrocarbons. Heated sodium is spontaneously flammable in air.

Spontaneous Heating: No

To Fight Fire: Soda ash, dry sodium chloride, or graphite in order of preference (Section 6).

Storage and Handling (Section 7): In the absence of moisture, oxygen or halides sodium is safe to handle. As to indoor storage of drums, "the important thing in storing sodium is that the storage area must be kept dry, since explosions may result from the contact of sodium with water. No automatic sprinkler system, or water or steam pipes containing water should be allowed in the room. Sufficient heat should be provided (without the use of open flames) to prevent condensation of moisture in the room due to changes in atmospheric conditions. Empty sodium drums should be stored in this same area.

"Fire extinguishers (preferably color-coded) must be provided in the storage area, but only those containing sodium chloride, sodium carbonate, or graphite may be used. Pails are adequate for storing extinguishent if special care is taken to insure that the materials are dry. Water, carbon dioxide, carbon tetrachloride, soda-acid, or conventional dry chemical (bicarbonate) extinguishers must be avoided, and signs should be posted in the storage area warning against their use.

"Only that amount of sodium immediately needed should be removed from the storage area. Sodium should not be withdrawn for intermediate storage in reaction areas. A special metal container with a tight fitting cover should be used for transporting sodium bricks to other plant areas, once they have been removed from the original container.

"Large-scale outdoor storage tanks such as tank cars are unloaded after melting the sodium by circulating hot oil and withdrawing the molten sodium by vacuum to storage tanks similar in construction to sodium tank cars. Although steam may be used to heat the circulating oil for use on both tank cars and storage tanks, steam must not be used directly as the heating agent for sodium tanks." *

Explosion Hazard: Dangerous, when exposed to moisture in any form! Keep dry at all times!

Disaster Control: Dangerous; when heated, it emits toxic fumes of sodium oxide; will react with water or steam to produce heat, hydrogen, and flammable vapors; can react vigorously with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid; yellow label.
  MCA warning label.

*Sittig, M., "Sodium, Its Manufacture, Properties and Uses," pp. 145-146, New York, Reinhold Publishing Corp., 1956

SODIUM ACETATE

Description: White crystals.

Formula: $NaC_2H_3O_2$

Constants:
  Mol. Wt. 82.0
  M. P. 324°C
  Density 1.528

Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1
  Acute Systemic: 0
  Chronic Local: 0
  Chronic Systemic: U

Fire Hazard: Slight, by chemical reaction; will react with water or steam to produce heat (Section 6).

Personal Hygiene: Section 3

Storage and Handling: Section 7

SODIUM p-ACETYLAMINOPHENYLANTIMONIATE

Synonym: Stibenyl.

Description: Light yellow powder; antimonial content 35%.

Formula:
  $CH_3CONHC_6H_4SbO_3HNa \cdot H_2O$

Constant:
  Mol. Wt. 345.93

Toxicity: Highly toxic. See Antimony Compounds.
Disaster Control: See Antimony Compounds.
Storage and Handling: Section 7

SODIUM m-ALUMINATE
Description: White, hygroscopic powder.
Formula: $NaAlO_2$
Constants:
Mol. Wt. 82.0
M. P. 1650°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U

SODIUM ALUMINUM FLUORIDE. See Sodium Fluoride and Aluminum Fluoride.

SODIUM ALUMINUM PHOSPHATE
Description: White powder.
Formula: $Na_3PO_4 \cdot AlPO_4$
Constant:
Mol. Wt. 285.92
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U

SODIUM AMALGAM
Description: Silver-white liquid or porous, crystalline mass; contains 2 to 10% metallic sodium; decomposes in water.
Formula: Na_xHg_y
For properties, see Sodium.

SODIUM AMIDE
Synonym: Sodamide.
Description: White crystalline powder.
Formula: $NaNH_2$
Constants:
Mol. Wt. 39.02
M. P. 210°C
B. P. 400°C
Toxicity: See Sodium Hydroxide and Ammonia, both of which are liberated by this material in the presence of moisture.
Fire Hazard: Moderate, by chemical reaction. See also Ammonia (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame or by chemical reaction with powerful oxidizers. See also Ammonia.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of ammonia and sodium oxide; will react with water or steam to produce heat and toxic and corrosive fumes; can react with oxidizing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

SODIUM ARSANILATE
Synonyms: Atoxyl; sodium-aniline arsonate; sodium aminophenyl arsonate.
Description: White, crystalline, odorless powder; faint salty taste.
Formula:
$C_6H_4NH_2(HOAsOONa) \cdot 4H_2O$
Constant:
Mol. Wt. 311.12
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

SODIUM ARSENATE
Synonym: Sodium o-arsenate.
Description: Clear, colorless crystals; mild alkaline taste.
Formula: $Na_3AsO_4 \cdot 12H_2O$
Constants:
Mol. Wt. 424.10
M. P. 86.3°C
Density 1.762 - 1.804
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification (solid): Poison B; poison label.

SODIUM m-ARSENATE
Description: Rhombic, efflorescent crystals.
Formula: $NaAsO_3$

Constants:
Mol. Wt. 145.91
Density 2.301
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

SODIUM ARSENITE
Description: Colorless or grayish-white powder.
Formula: $NaAsO_2$
Constants:
Mol. Wt. 129.91
Density 1.87
Toxicity: Highly toxic. See Arsenic Compounds.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Poison B (solution); poison label.
Coast Guard Classification: Poison B (solution); poison label.

SODIUM ARSPHENAMINE
Synonyms: Sodium diarsenal; sodium arsphenolamine.
Description: Bright yellow powder; contains not less than 19% arsenic.
Formula:
$NaONH_2C_6H_3AsAsC_6H_3NH_2ONa$
Constant:
Mol. Wt. 410.08
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 11.

SODIUM AURIDE
Description: Cubic yellow crystals.
Formula: $NaAu_2$
Constants:
Mol. Wt. 417.40
M. P. Decomposes @700°C
Toxicity: See Gold Compounds.

SODIUM AZIDE
Description: Colorless, hexagonal crystals.
Formula: NaN_3
Constants:
Mol. Wt. 65.02
B. P. Decomposes in vacuum
Density 2.846
Toxicity: See Azides and Sodium Hydroxide.
Explosion Hazard: Moderate, when shocked or exposed to heat, especially when contaminated by certain materials.
Disaster Control: Dangerous; shock will explode it; when heated to decomposition, it emits toxic fumes of nitrogen oxides, and may explode.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

SODIUM BARBITAL
Description: White powder.
Formula: $NaC_8H_{11}N_2O_3$
Constant:
Mol. Wt. 206.18
Toxicity: Moderate. See Barbiturates.
Fire Hazard: Slight; when heated to decomposition, it emits toxic fumes of nitrogen oxides.
Storage and Handling: Section 7

SODIUM BENZOATE
Synonym: Benzoate of soda.
Description: White, odorless, crystalline solid.
Formula: $NaC_7H_5O_2$
Constant:
Mol. Wt. 144.1
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Ingestion 1
Chronic Local: 0
Chronic Systemic: 0
Toxicology: Large doses of 8 to 10 grams by mouth may cause nausea and vomiting. It is possible to tolerate as much as 50 grams per day. Small doses have little or no effect. A fungicide. See also Benzoic Acid.
Fire Hazard: Slight; when heated, it emits acrid fumes.
Storage and Handling: Section 7

SODIUM BICHROMATE. See Sodium Dichromate.

SODIUM BIFLUORIDE, See Sodium Difluoride.

SODIUM BISULFATE
Synonyms: Sodium hydrogen sulfate; sodium acid sulfate.
Description: Colorless crystals.
Formula: $NaHSO_4$
Constants:
Mol. Wt. 120.1
M. P. > 315°C (decomp.)
Density 2.435 @13°C
Toxicity: Toxic. See Sulfuric acid which is liberated on contact with moisture.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; will react with water or steam to produce heat and toxic fumes.
Storage and Handling: Section 7

SODIUM BISULFITE
Synonym: Sodium hydrogen sulfite.
Description: White crystals.
Formula: $NaHSO_3$
Constants: Mol. Wt. 104.1
Density 1.48
Toxicity: See Sulfites.
Disaster Control: See Sulfites.
Storage and Handling: Section 7

SODIUM BORATE. See Sodium Tetraborate.

SODIUM BORATE PERHYDRATE
Description: Crystals.
Formula: $NaBO_2 \cdot H_2O_2$
Constants: Mol. Wt. 99.8
M. P. Decomp. @40°C
For other properties, see Peroxides.

SODIUM BOROHYDRIDE
Description: White to gray-white micro-crystalline powder or lumps.
Formula: $NaBH_4$
Constants:
Mol. Wt. 37.85
M. P. > 400°C
Density 1.07
Toxicity: See Boron Compounds and Hydrides.
Fire Hazard: Moderate, when exposed to heat or flame or by chemical reaction with oxidizers.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes; will react with water or steam to produce hydrogen; on contact with acid fumes, it can emit flammable vapors.
Storage and Handling: Section 7

SODIUM BROMATE
Description: White crystals or crystalline powder.
Formula: $NaBrO_3$
Constants:
Mol. Wt. 150.91
M. P. 381°C
Density 3.339 @17.5°C
For other properties, see Bromates.
Shipping Regulations: Section 11.
Coast Guard Classification: Oxidizing material; yellow label.

SODIUM BROMIDE
Description: Cubic, colorless crystals.
Formula: NaBr
Constants:
Mol. Wt. 102.91
M. P. 755°C
B. P. 1390°C
Density 3.203 @25°C
Vap. Press. 1 mm @806°C
For other properties, see Bromides.

SODIUM BROMOAURATE
Description: Brown-black crystals.
Formula: $NaAuBr_4 \cdot 2H_2O$
Constant:
Mol. Wt. 575.89
Toxicity: See Gold Compounds and Bromides.

SODIUM 2-BROMO-4-PHENYLPHENOL
Formula:
$NaOC_6H_3Br(C_6H_5)$
Constant:
Mol. Wt. 271
Toxicity: Toxic. See Phenols.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromine compounds.
Storage and Handling: Section 7

SODIUM BROMOPLATINATE
Description: Dark red crystals.
Formula: $Na_2PtBr_6 \cdot 6H_2O$
Constants:
Mol. Wt. 828.8
M. P. Decomposes @150°C
Density 3.323
Toxicity: See Platinum Compounds.
Disaster Control: See Bromides.
Storage and Handling: Section 7

SODIUM CACODYLATE

Synonyms: Sodium dimethyl arsenate; arsysodila.
Description: White, amorphous powder.
Formula: $NaAsC_2H_6O_2 \cdot 3H_2O$
Constants:
  Mol. Wt. 214.02
  M. P. Approx. 60°C
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Poison B; poison label.
  Coast Guard Classification: Poison B; poison label.

SODIUM CARBIDE

Description: White powder.
Formula: Na_2C_2
Constants:
  Mol. Wt. 70.01
  B. P. 700°C
  Density 1.575 @ 15°C
Toxicity: See Sodium Hydroxide and Acetylene (liberated on contact with water).
Fire Hazard: Moderate, by chemical reaction with oxidizers.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride.
Explosion Hazard: Moderate, by chemical reaction; also on contact with bromine. See Acetylene.
Disaster Control: See Carbides.
Storage and Handling: Section 7

SODIUM CARBONATE

Synonyms: Soda monohydrate; crystal carbonate.
Description: White, odorless, small crystals or crystalline powder; alkaline taste.
Formula: Na_2CO_3
Constants:
  Mol. Wt. 106.00
  M. P. 851°C
  B. P. Decomposes
  Density 2.509 @ 0°C
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: Irritant 1
  Chronic Systemic: U
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

SODIUM CARBONATE PEROXIDE

Description: Fine white powder.
Formula: $2Na_2CO_3 \cdot 3H_2O_2$
Constant:
  Mol. Wt. 314
Toxicity: See Sodium Carbonate and Hydrogen Peroxide.

SODIUM CARBONYL

Formula: $NaCO$
Constant:
  Mol. Wt. 51
Toxicity: Highly toxic. See Carbonyls.
Fire Hazard: Moderate, when exposed to heat or by chemical reaction with oxidizers. Heat causes evolution of carbon monoxide.
Explosion Hazard: Moderate, when exposed to heat or by chemical reaction.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of sodium oxide and carbon monoxide; it may explode on heating.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

SODIUM CHLORATE

Synonym: Soda chlorate.
Description: Colorless, odorless crystals; cooling, saline taste.
Formula: $NaClO_3$
Constants:
  Mol. Wt. 106.45
  M. P. 248 - 261°C
  B. P. Decomposes
  Density 2.490 @15°C
For other properties, see Chlorates.
Shipping Regulations: Section 11.
  I. C. C. Classification: Oxidizing material; yellow label.
  Coast Guard Classification: Oxidizing material; yellow label.
  MCA warning label.

SODIUM CHLORIDE

Synonyms: Salt; halite; sea salt.
Description: Colorless, transparent

crystals or white, crystalline powder.
Formula: NaCl
Constants:
Mol. Wt. 58.45
M. P. 801°C
B. P. 1413°C
Density 2.165
Vap. Press. 1 mm @865°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1
Acute Systemic: 0
Chronic Local: 0
Chronic Systemic: 0
Toxicology: When bulk sodium chloride is heated to high temperature, a vapor is emitted which is irritating to the eyes, particularly. Ingestion of large amounts of sodium chloride can cause irritation of the stomach. Improper use of salt tablets may produce this effect.
Storage and Handling: Section 7

SODIUM CHLORITE

Description: White crystals or crystalline powder.
Formula: $NaClO_2$
Constants:
Mol. Wt. 90.45
B. P. Decomposes @175° $\rightarrow O_2$
Toxicity: Virtually nontoxic.
Fire Hazard: A powerful oxidizing agent; ignited on friction, heat or shock (Section 6).
Explosion Hazard: Moderate, when shocked or exposed to heat or flame.
Disaster Control: Dangerous; shock will explode it; when heated, it emits highly toxic fumes of chlorides and may explode; can react vigorously on contact with reducing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

SODIUM CHLORITE SOLUTION (NOT EXCEEDING 40% SODIUM CHLORITE).

Shipping Regulations: Section 11.
I.C.C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

SODIUM CHLOROACETATE

Description: White, odorless, free-flowing powder.
Formula: $ClCH_2COONa$
Constants:
Mol. Wt. 116.49
M. P. Decomposes @200°C
Flash P. None
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

SODIUM CHLOROAURATE

Description: Rhombic, yellow crystals.
Formula: $NaAuCl_4 \cdot 2H_2O$
Constants:
Mol. Wt. 398.06
M. P. Decomposes
Toxicity: See Gold Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

SODIUM CHLOROIRIDATE

Description: Dull red-black crystals.
Formula: $Na_2IrCl_6 \cdot 6H_2O$
Constants:
Mol. Wt. 559.93
M. P. Decomposes @600°C
Toxicity: See Iridium Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

SODIUM 4-CHLORO-2-METHYLPHENOXYACETATE

Toxicity: Details unknown; a fungicide.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

SODIUM CHLORO-2-PHENYLPHENATE

Synonyms: Sodium-2-chloro-o-phenylphenate.
Toxicity: Details unknown; a fungicide.
Disaster Control: Dangerous; when heated to decomposition, it emits

highly toxic fumes of chlorides.
Storage and Handling: Section 7

SODIUM CHLOROPLATINATE
Description: Orange-yellow powder.
Formula: Na_2PtCl_6
Constants:
Mol. Wt. 453.97
M. P. 150 - 160°C
Toxicity: See Platinum Compounds.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

SODIUM CHROMATE
Description: Yellow, rhombic crystals.
Formula: Na_2CrO_4
Constants:
Mol. Wt. 162.00
Density 2.710
For other properties, see Chromium Compounds.

SODIUM COMPOUNDS
Toxicity: ·Variable. Sodium ion is practically nontoxic. The toxicity of sodium compounds is frequently, though not always, due to the anion involved. The hydroxide is very corrosive, being strongly basic. Even here it is the concentration of hydroxyl ion which is responsible for the caustic action of this material.

SODIUM COPPER POLYPHOSPHATE
See Copper Compounds.

SODIUM CYANATE
Description: Colorless needles.
Formula: NaOCN
Constants:
Mol. Wt. 65.92
Density 1.937 @ 20°C
Toxicity: Highly toxic. See Cyanates.
Disaster Control: See Cyanates.
Storage and Handling: Section 7

SODIUM CYANIDE
Description: White, deliquescent, crystalline powder.
Formula: NaCN
Constants:
Mol. Wt. 49.02
M. P. 563.7°C
B. P. 1496°C
Vap. Press. 1 mm @817°C
Toxicity: Highly toxic. For other properties, see Cyanides.
Shipping Regulations: Section 11. MCA warning label

SODIUM CYANOAURITE
Synonym: Sodium aurocyanide.
Description: White, crystalline powder.
Formula: $NaAu(CN)_2$
Constant:
Mol. Wt. 272.23
Toxicity: Highly toxic. See Cyanides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes it emits highly toxic fumes of cyanides.
Storage and Handling: Section 7

SODIUM 2,4-DICHLOROPHENOXYETHYL SULFATE
Description: Crystals.
Formula: $Cl_2C_6H_3OC_2H_4OSO_3Na$
Constant:
Mol. Wt. 309.11
Toxicity: Unknown
MAC: ACGIH (tentative); 15 milligrams per cubic meter of air.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

SODIUM DICHROMATE
Synonym: Sodium acid chromate.
Description: Red crystals.
Formula: $Na_2Cr_2O_7 \cdot 2H_2O$
Constants:
Mol. Wt. 298.1
M. P. $-2H_2O$ @100°C; anhyd. @320°C
B. P. Decomposes @400°C
Density 2.52 @13°C
For other properties, see Chromium Compounds.
Shipping Regulations: Section 11. MCA warning label

SODIUM DICYANAMIDE
Description: Colorless crystals.
Formula: $NaN(CN)_2$
Constants:
Mol. Wt. 89.04
M. P. > 315°C (decomp.)
Density 1.701 @30°C

Toxicity: Highly toxic. See Calcium Cyanamide.

Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides.

Storage and Handling: Section 7

SODIUM DIETHYLDITHIOCARBAMATE

Description: Liquid.

Formula: $NaSC(S)N(C_2H_5)_2$

Constants:

Mol. Wt. 171.3

M. P. 16 - 19°C

Density 1.1 @20°/20°C

Vap. D. 5.9

Toxicity: Details unknown. See also Carbamates.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of sulfur and nitrogen oxides.

Ventilation Control (use normal rate): Section 2

Storage and Handling: Section 7

SODIUM DIFLUORIDE

Description: White powder.

Formula: $NaF \cdot HF$

Toxicity: Highly toxic. See Fluorides and Hydrofluoric Acid.

Disaster Control: Dangerous. See Fluorides.

Storage and Handling: Section 7

SODIUM DI-HYDROGEN o-ARSENATE

Description: Rhombic or monoclinic, colorless crystals.

Formula: $NaH_2AsO_4 \cdot H_2O$

Constants:

Mol. Wt. 181.94

M. P. $-H_2O$ @100 - 130°C

B. P. Decomposes @200 - 280°C

Density 2.53

Toxicity: Highly toxic. See Arsenic Compounds.

Disaster Control: See Arsenic Compounds.

Storage and Handling: Section 7

SODIUM-6,7-DIHYDROXY-2-NAPHTHALENE SULFONATE

Description: Dry paste.

Formula $C_{10}H_6(OH)_2SO_3Na$

Constant:

Mol. Wt. 263.2

Toxicity: Unknown

Disaster Control: Dangerous; when heated to decomposition, it can emit toxic fumes of oxides of sulfur.

Storage and Handling: Section 7

SODIUM p-DIMETHYLAMINOBENZENE DIAZOSULFONATE

Toxicity: Details unknown. A rodenticide of moderate toxicity developed in Germany.

Disaster Control: Moderately dangerous; when heated, it emits toxic fumes of sulfur and nitrogen oxides.

Storage and Handling: Section 7

SODIUM DIMETHYL DITHIOCARBAMATE

Description: Crystals.

Formula: $(CH_3)_2NCS_2Na$

Constant:

Mol. Wt. 143.2

Toxicity: Details unknown. See also Carbamates.

Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of sulfur and nitrogen oxides.

Storage and Handling: Section 7

SODIUM DINITRO-o-CRESYIATE

Description: Brilliant orange-yellow dye.

Formula: $C_6H_2(ONa)(NO_2)_2(CH_3)$

Constant:

Mol. Wt. 220.1

Toxicity: Probably toxic; an insecticide and selective herbicide. See also Dinitrophenol.

Fire Hazard: Moderate. See Nitrates.

Disaster Control: Dangerous. See Nitrates.

Storage and Handling: Section 7

SODIUM DINITROPHENOL

Formula: $C_6H_3(ONa)(NO_2)_2$

Constant:

Mol. Wt. 206.1

Toxicity: Probably toxic. See Dinitrophenol.

Fire Hazard: Moderate. See Nitrates.

Explosion Hazard: Severe, when shocked or exposed to heat. See also Nitrates.

Explosive Range: @698°F.
Disaster Control: Dangerous; when heated it emits toxic fumes and may explode.
Storage and Handling: Section 7

SODIUM DISPERSIONS

Description: Finely divided metallic sodium suspended in toluene, xylene, naphtha, kerosene, etc.
Toxicity: Highly toxic. See Sodium and individual dispersant.
Fire Hazard: Dangerous, when exposed to heat or flame or by chemical reaction. These are very reactive forms of sodium, which if carelessly handled may catch fire. To extinguish, see Sodium. After sodium has been extinguished, the burning organic vapor can be dealt with by very cautious use of a carbon dioxide extinguisher. Do not use carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, by chemical reaction. See also Sodium.
Disaster Control: Dangerous; when heated, it emits highly toxic fumes of sodium, sodium oxide, etc.; will react with water or steam to produce heat and hydrogen; on contact with oxidizing materials, it can react vigorously and on contact with acid or acid fumes, it can emit toxic fumes.
Storage and Handling: Section 7

SODIUM ETHYLATE

Synonym: Caustic alcohol.
Description: White powder, sometimes having brownish tinge.
Formula: C_2H_5ONa
Constant:
Mol. Wt. 68.05
Toxicity: See Sodium Hydroxide and Ethyl Alcohol, into which it readily hydrolyzes.
Fire Hazard: Dangerous; when exposed to heat or flame.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

SODIUM ETHYL MERCURITHIOSALICYLATE. See Mercury Compounds, Organic.

SODIUM ETHYL SULFATE

Synonym: Sodium sulfovinate
Description: White hygroscopic crystalline material.
Formula: $NaC_2H_5SO_4 \cdot H_2O$
Constant: Mol. Wt. 166.14
Toxicity: See Sulfuric Acid and Ethyl Alcohol.
Disaster Control: When strongly heated, it emits toxic fumes.

SODIUM ETHYL XANTHATE

Synonym: Sodium xanthogenate.
Description: Yellowish powder, soluble in water and alcohol.
Formula: $C_2H_5OCSSNa$
Constant: Mol. Wt. 144.2
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame. See Sulfides.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

SODIUM FERRICYANIDE

Synonyms: Red prussiate of sodium; red prussiate of soda.
Description: Ruby-red, deliquescent crystals.
Formula: $Na_3Fe(CN)_6 \cdot H_2O$
Constant: Mol. Wt. 298.96
Toxicity: Moderate. See Ferricyanides.
Disaster Control: See Ferricyanides.
Storage and Handling: Section 7

SODIUM FERROCYANIDE

Synonym: Yellow prussiate of soda.
Description: Yellow crystals.
Formula: $Na_4Fe(CN)_6 \cdot 10H_2O$
Constants: Mol. Wt. 484.1
Density 1.458
Toxicity: Moderate. See Ferrocyanides.
Disaster Control: See Ferrocyanides.
Storage and Handling: Section 7

SODIUM FLUOACETATE. See Sodium Fluoroacetate.

SODIUM FLUOALUMINATE

Description: Colorless crystals.

Formula: Na_3AlF_6
Constants:
Mol. Wt. 209.96
M. P. 1000°C
Density 2.90
Toxicity: Highly toxic. See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

SODIUM FLUOANTIMONATE

Formula: $NaSbF_6$
Constants:
Mol. Wt. 258.76
Density 3.375
Toxicity: Highly toxic. See Antimony Compounds and Fluorides.
Disaster Control: See Antimony Compounds and Fluorides.
Storage and Handling: Section 7

SODIUM FLUOBERYLLATE

Description: Rhombic or monoclinic, white crystals.
Formula: Na_2BeF_4
Constants:
Mol. Wt. 131.01
M. P. Decomposes
Toxicity: Highly toxic. See Beryllium Compounds and Fluorides.
Disaster Control: See Beryllium Compounds and Fluorides.
Storage and Handling: Section 7

SODIUM FLUOBORATE

Description: White, rhombic crystals.
Formula: $NaBF_4$
Constants:
Mol. Wt. 109.82
M. P. 384°C (slight decomp.)
B. P. Decomposes
Density 2.47 @ 20°C
Toxicity: Highly toxic. See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

SODIUM FLUORIDE

Synonym: Villiaumite.
Description: Clear, lustrous crystals or white powder or balls.
Formula: NaF
Constants:
Mol. Wt. 42.00
M. P. 980 - 997°C
B. P. 1700°C
Density 2.558 @ 41°C
Vap. Press. 1 mm @ 1077°C
Toxicity: Probably toxic. See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7
Shipping Regulations: Section 11. MCA warning label

SODIUM FLUOROACETATE (also known as 1080)

Description: Fine, white odorless powder.
Formula: FCH_2COONa
Toxicity: An insecticide. This material has a strong effect on either or both the cardiovascular and nervous systems in all species and in some species on the skeletal muscles. Man gives a mixed type response with the cardiac feature predominating. By a direct action on the heart, notably in the rabbit, contractible power is lost which leads to declining blood pressure. Ventricular premature contractions are seen in all species and arrhythmias are especially marked in some species including man. The central nervous system, notably that of the dog, is directly attacked by sodium fluoroacetate. In man, the action on the central nervous system produces epileptiform convulsive seizures followed by severe depression.

The dangerous dose for man is 0.5 to 2 mg/kg. Other species vary considerably in their response to sodium fluoroacetate with primates and birds being the most resistant and carnivora and rodents being the most susceptible. Most domestic animals show a susceptibility falling between the two extremes indicated above.

The first indication of poisoning is nausea and mental apprehension followed by epileptiform convulsions. After a period of several hours, pulsus alternans may exist followed by ventricular fibrillation and death. Children appear to be more subject to cardiac arrest than to ventricular fibrillation.

Treatment: The treatment for sodium fluoroacetate poisoning is mainly symptomatic. Immediate emesis and stomach lavage followed by oral doses of magnesium sulfate are useful. Administration of certain compounds capable of supplying acetate ions have shown antidotal effects in animals, including monkeys; the choice drugs being monacetin (glycerol monoacetate) (2 to 4 g/kg) and a combination of sodium acetate and theonol (2 g/kg of each). A single dose of magnesium sulfate (800 mg/kg) given intramuscularly as a 50 percent solultion has saved the live of rats dosed with lethal amounts of sodium fluoroacetate. Complete quiet and rest are indicated, but barbiturate anesthesia has proved disappointing when used as an antidote.

SODIUM FLUOSILICATE
Description: White powder.
Formula: Na_2SiF_6
Constants:
  Mol. Wt. 188.1
  M. P. Decomposes
  Density 2.679
Toxicity: Highly toxic. See Fluosilicates.
Disaster Control: See Fluosilicates.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  MCA warning label.

SODIUM FLUOSULFONATE
Description: Shiny, hygroscopic leaflets.
Formula: $NaSO_3F$
Constants:
  Mol. Wt. 122.07
  M. P. Decomposes @red heat
Toxicity: Highly toxic. See Fluosulfonates.
Disaster Control: See Fluosulfonates.
Storage and Handling: Section 7

SODIUM FORMATE
Description: White, deliquescent crystals.
Formula: HCOONa
Constants:
  Mol. Wt. 68.0
  M. P. 253°C
  Density 1.92 @20°C
Toxicity: See Formic Acid.
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Storage and Handling: Section 7

SODIUM m-GERMANATE
Description: Monoclinic, white, deliquescent crystals.
Formula: Na_2GeO_3
Constants:
  Mol. Wt. 166.59
  M. P. 1083°C
  Density 3.31 @22°C
Toxicity: See Germanium Compounds.

SODIUM HEXAFLUOROPHOSPHATE
Description: White solid.
Formula: $NaPF_6 \cdot H_2O$
Constants:
  Mol. Wt. 185.99
  Density 2.369 @19°C
Toxicity: Highly toxic. See Fluorophosphates.
Disaster Control: See Fluorophosphates.
Storage and Handling: Section 7

SODIUM HYDRIDE
Description: Microcrystalline, white to brownish-gray powder.
Formula: NaH
Constants:
  Mol. Wt. 24.00
  M. P. 800°C (decomp.)
  Density 0.92
Toxicity: Highly toxic. See Sodium Hydroxide.
Fire Hazard: Moderate, when exposed to heat or flame or by chemical reaction with oxidizers.
To Fight Fire: Special mixtures of dry chemical (Section 6).
Explosion Hazard: Moderate, when exposed to heat or flame or by chemical reaction. See also Hydrides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxide of sodium; it will react with water or steam to produce heat, sodium hydroxide and hydrogen; can react with oxidizing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid; yellow label.

SODIUM HYDROGEN FLUORIDE.
See Sodium Difluoride.

SODIUM HYDROGEN OXALATE
Description: Monoclinic, white crystals.
Formula: $NaHC_2O_4 \cdot H_2O$
Constant:
  Mol. Wt. 130.04
Toxicity: Highly toxic. See Oxalates.

SODIUM HYDROGEN SULFITE.
See Sodium Bisulfite.

SODIUM HYDROSULFIDE
Synonym: Sodium sulfhydrate.
Description: Colorless needles.
Formula: NaSH
Constants:
  Mol. Wt. 56.07
  M. P. 350°C
For other properties, see Sulfides.
Storage and Handling: Section 7
MCA warning label.

SODIUM HYDROSULFITE
Synonyms: Sodium dithionite; sodium hyposulfite.
Description: Light lemon-colored solid in powder or flake form or white to grayish-white crystalline powder.
Formula: $Na_2S_2O_4 \cdot 2H_2O$
Constants:
  Mol. Wt. 210.16
  M. P. 55°C (decomp.)
Toxicity: See Sulfites.
Fire Hazard: Moderate, when exposed to heat and moisture (Section 6).
Disaster Control: See Sulfites.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid; yellow label.
  MCA warning label.

SODIUM HYDROXIDE
Synonyms: Caustic soda; sodium hydrate; lye; white caustic.
Description: White, deliquescent pieces, lumps or sticks.
Formula: NaOH
Constants:
  Mol. Wt. 40.01
  M. P. 318.4°C
  B. P. 1390°C
  Density 2.130
  Vap. Press. 1 mm @739°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 2
  Acute Systemic: U
  Chronic Local: Irritant 2
  Chronic Systemic: U
MAC: ACGIH (tentative); 2 milligrams per cubic meter of air.
Toxicology: This material, both solid and in solution, has a markedly corrosive action upon all body tissue. The symptoms of irritation from this material are frequently evident immediately. Its corrosive action on tissue causes burns and frequently deep ulceration, with ultimate scarring. Prolonged contact with dilute solutions has a destructive effect upon tissue. Mists, vapors, and dusts of this compound cause small burns, and contact with the eyes, either in the solid or solution form, rapidly causes severe damage to the delicate tissue. Ingestion either in the solid or solution form causes very serious damage to the mucous membranes or other tissues with which contact is made. It can cause perforation and scarring. Inhalation of the dust or concentrated mist can cause damage to the upper respiratory tract and to lung tissue, depending upon the severity of the exposure. Thus, effects of inhalation may vary from mild irritation of the mucous membranes to a severe pneumonitis. It can cause an irritant dermatitis (Section 9).
Treatment and Antidotes: Speed in removing this caustic from contact with the skin of one who has come in contact with it is important to avoid injury. Remove all contaminated clothing at once and if possible give patient a shower under deluge type of shower using plenty of water. If the eyes are involved, they should be irrigated at once with plenty of warm water for 15 minutes. Persons so injured should be referred to a physician.
Disaster Control: Dangerous; will react with water or steam to produce heat and will attack organic tissue.

Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Hazardous material.
MCA warning label.

SODIUM HYDROXIDE, SOLUTION.

See Sodium Hydroxide.
Shipping Regulations: Section 11.
Coast Guard Classification: Corrosive liquid; white label.

SODIUM HYDROXOPLUMBATE

Description: Light yellow-white, fused, hygroscopic lumps.
Formula: $Na_2Pb(OH)_6$
Constant:
Mol. Wt. 355.25
Toxicity: Highly toxic. See Lead Compounds.
Disaster Control: See Lead Compounds.
Storage and Handling: Section 7

SODIUM HYDROXOSTANNATE

Description: Hexagonal, colorless, white powder or lumps.
Formula: $Na_2Sn(OH)_6$
Constants:
Mol. Wt. 266.74
M. P. $-3H_2O$ @140°C
Toxicity: See Tin Compounds.

SODIUM-2-HYDROXY-3,6-NAPHTHALENE SULFONATE. See Sodium β-naphthol Disulfonate.

SODIUM HYPOCHLORITE

Formula: NaClO
Constants:
Mol. Wt. 74.45
M. P. Decomposes
B. P. Decomposes
For other properties, see Hypochlorites.

SODIUM HYPONITRITE

Description: Crystals.
Formula: $Na_2N_2O_2$
Constants:
Mol. Wt. 106.01
M. P. Decomposes @300°C
Density 2.466 @4°C
Toxicity: See Nitrites.
Fire Hazard: Moderate, by chemical reaction; a strong oxidizer. See also Nitrites.
Explosion Hazard: Slight, when exposed to heat.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen.
Storage and Handling: Section 7

SODIUM HYPOPHOSPHITE

Description: Colorless, pearly, crystalline plates or white, granular powder; bitter sweet, saline taste.
Formula: $NaH_2PO_2 \cdot H_2O$
Constant:
Mol. Wt. 106.01
Toxicity: See Hypophosphites.
Fire Hazard: Moderate. See Hypophosphites.
Explosion Hazard: Moderate, when exposed to heat. Sodium hypophosphite may detonate if heated. It must be kept cool, and stored in a cool, ventilated place, away from acute fire hazards. It may be disposed of by dissolving in water (Section 7).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

SODIUM IODATE

Description: Rhombic, white crystals.
Formula: $NaIO_3$
Constants:
Mol. Wt. 197.92
M. P. Decomposes
Density 4.277 @17.5°C
For other properties, see Iodates.

SODIUM IODIDE

Description: Cubic, colorless crystals.
Formula: NaI
Constants:
Mol. Wt. 149.92
M. P. 651°C
B. P. 1300°C
Density 3.667
Vap. Press. 1 mm @767°C
For other properties, see Iodides.

SODIUM ISOPROPYL XANTHATE

Formula: $SC(OC_3H_7)SNa$
Constant:
Mol. Wt. 158.3
Toxicity: Unknown
Fire Hazard: Moderate, by chemical reaction with oxidizers. See also Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

SODIUM-LEAD ALLOY

Description: Metallic material.
Composition: $(Na)_x + (Pb)_y$
Toxicity: Highly toxic. See Lead Compounds and Sodium.
Fire Hazard: Moderate; reacts with moisture and acids to evolve hydrogen and heat; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, by chemical reaction to produce hydrogen.
Disaster Control: Dangerous. See Lead Compounds and Sodium. See also Hydrogen which is liberated on contact with moisture.
Storage and Handling: Section 7

SODIUM LEAD POLYPHOSPHATE

Description: Dense white powder.
Toxicity: See Lead Compounds.
Disaster Control: See Lead Compounds.
Storage and Handling: Section 7

SODIUM MANGANATE

Description: Monoclinic, green crystals.
Formula: $Na_2MnO_4 \cdot 10H_2O$
Constants:
Mol. Wt. 345.08
M. P. 17°C
Toxicity: See Manganese Compounds.
Fire Hazard: Moderate, by chemical reaction; an oxidizer (Section 6)
Storage and Handling: Section 7

SODIUM, METALLIC, DISPERSION IN ORGANIC SOLVENT. See Sodium Dispersions.
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

SODIUM, METALLIC, LIQUID ALLOY

Shipping Regulations: Section 11.
I. C. C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

SODIUM METHANE ARSENATE

Synonym: Sodium methyl arsenate.
Description: White, crystalline powder.
Formula: $Na_2CH_3AsO_3 \cdot 6H_2O$
Constants:
Mol. Wt. 292.03
M. P. 130 - 140°C
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds
Storage and Handling: Section 7

SODIUM 2-(N-METHYLAMINO) ETHANE SULFONATE

Synonym: Sodium N-methyltaurine.
Description: Clear, colorless liquid.
Formula: $HN(CH_3)CH_2CH_2SO_3Na$
Constants:
Mol. Wt. 161
M. P. −26.5 to −30°C
Density 1.202-1.218
Vap. D. 5.55
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

SODIUM METHYLARSENATE. See Sodium Methanearsenate.

SODIUM MONOFLUOROACETATE. See Sodium Fluoroacetate.

SODIUM MONOFLUOROPHOSPHATE

Description: Colorless crystals.
Formula: Na_2PO_3F
Constants:
Mol. Wt. 143.97
M. P. Approx. 625°C
Toxicity: See Fluorophosphates.

Disaster Control: See Fluorophosphates.
Storage and Handling: Section 7

SODIUM MONOHYDROGEN o-ARSENATE

Description: Monoclinic, colorless crystals.
Formula: $Na_2HAsO_4 \cdot 7H_2O$
Constants:
Mol. Wt. 312.02
M. P. 120 - 130°C; $-H_2O$ @180°C
Density 1.88
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

SODIUM MONOXIDE

Description: White-gray, deliquescent crystals.
Formula: Na_2O
Constants:
Mol. Wt. 61.99
B. P. 1275°C (sublimes)
Density 2.27
Toxicity: Highly toxic. See Sodium Hydroxide.
Disaster Control: See Sodium Hydroxide.
Storage and Handling: Section 7

SODIUM β-NAPHTHOL DISULFONATE

Synonyms: R salt.
Description: Gray paste.
Formula: $(NaSO_3)_2C_{10}H_5OH$
Constant:
Mol. Wt. 348.26
Toxicity: Details unknown. See also β-Naphthol.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

SODIUM NITRATE

Synonyms: Soda niter; nitratine.
Description: Colorless, transparent, odorless crystals; saline, slightly bitter taste.
Formula: $NaNO_3$
Constants:
Mol. Wt. 85.01
M. P. 306.8°C
B. P. Decomposes @380°C
Density 2.261
Toxicity: See Nitrates.
Fire Hazard: Moderate, when mixed with organic matter, it will ignite on friction. See Nitrates.
Explosion Hazard: Explodes when heated to over 1000°C or when mixed with cyanides.
Disaster Control: Dangerous. See Nitrates.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

SODIUM NITRIDE

Description: Dark gray crystals.
Formula: Na_3N
Constants:
Mol. Wt. 83.00
M. P. Decomposes @300°C
Toxicity: Highly toxic. See Sodium Hydroxide and Ammonia.
Fire Hazard: Moderate, by chemical reaction with water (Section 6).
Explosion Hazard: Moderate, when exposed to heat or by chemical reaction. See also Ammonia.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of sodium; will react with water or steam to produce toxic, corrosive and flammable vapors.
Storage and Handling: Section 7

SODIUM NITRITE

Synonym: Diazotizing salts.
Description: Slightly yellowish or white crystals, sticks or powder.
Formula: $NaNO_2$
Constants:
Mol. Wt. 69.01
M. P. 271°C
B. P. Decomposes @320°C
Density 2.168
Toxicity: See Nitrites.
Fire Hazard: Moderate; a strong oxidizing agent. In contact with organic matter will ignite by friction. See Nitrites.
Explosion Hazard: Explodes when heated to over 1000°F or on contact with cyanides.
Disaster Control: Dangerous. See Nitrites.

Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

SODIUM NITRITE MIXED (FUSED) WITH POTASSIUM NITRITE,

See Nitrites.

SODIUM m-NITRO BENZENE SULFONATE

Description: Crystals.
Formula: $NO_2C_6H_4OSO_2Na$
Constants:
Mol. Wt. 225.2
Toxicity: Details unknown. See also Nitrobenzene.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen.
Storage and Handling: Section 7

SODIUM NITROMETHANE

Formula: $NaCH_2NO_2$
Constant:
Mol. Wt. 83.3
Toxicity: Details unknown. See also Nitroparaffins.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: Severe, when shocked or exposed to heat.
Disaster Control: Dangerous; shock will explode it; when heated to decomposition it emits highly toxic fumes of oxides of nitrogen; can react with reducing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

SODIUM p-NITROPHENOXIDE

Synonym: Sodium nitrophenate.
Description: Yellow prisms.
Formula: $NaOC_6H_4NO_2 \cdot 4H_2O$
Constants:
Mol. Wt. 233.16
M. P. $-2H_2O$ @ 36 °C; $-4H_2O$ @ 120 °C
B. P. Decomposes
Toxicity: Highly toxic. See p-Nitrophenol and Sodium Hydroxide.
Fire Hazard: Moderate. See Nitrates.
Explosion Hazard: Moderate. See Nitrates.
Disaster Control: Dangerous. See Nitrates.
Storage and Handling: Section 7

SODIUM NITROPRUSSIDE

Description: Rhombic, red crystals.
Formula: $Na_2Fe(NO)(CN)_5 \cdot 2H_2O$
Constants:
Mol. Wt. 297.97
Density 1.72
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 2
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
Toxicology: The effects of this material are similar to that of nitrites, causing fall in blood pressure but no formation of methemoglobin. Large amounts, when taken internally, may form cyanide upon being metabolized.
Disaster Control: Dangerous; when heated or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

SODIUM OLEATE

Description: White powder; slight tallow odor.
Formula: $C_{17}H_{33}COONa$
Constants: Mol. Wt. 304.5
M. P. 232-235 °C
Toxicity: See Oleic Acid.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Storage and Handling: Section 7

SODIUM OXALATE

Description: White, crystalline powder.
Formula: $Na_2C_2O_4$
Constants:
Mol. Wt. 134.01
Density 2.34
Toxicity: Highly toxic. See Oxalates.

SODIUM OXIDE. See Sodium Monoxide.

SODIUM PENTABORATE. See Sodium Borate.

SODIUM PENTACHLOROPHENATE
Description: Tan powder.
Formula: C_6Cl_5ONa
Constant:
Mol. Wt. 288.4
Toxicity: See Pentachlorophenol.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

SODIUM PENTACHLOROPHENOLATE. See Sodium Pentachlorophenate.

SODIUM PENTASULFIDE
Description: Yellow crystals.
Formula: Na_2S_5
Constants:
Mol. Wt. 206.32
M. P. 251.8°C
For other properties, see Sulfides.

SODIUM PENTOBARBITAL
Description: White powder.
Formula: $NaC_{11}H_{17}N_2O_3$
Constant:
Mol. Wt. 248.26
Toxicity: See Barbiturates.

SODIUM PERBORATE
Synonym: Metaborate peroxyhydrate, sodium perborate tetrahydrate.
Description: White crystals with saline taste, slightly water-soluble.
Formula: $NaBO_2H_2O_2 \cdot 3H_2O$
Constants:
Mol. Wt. 153.9
M. P. 62°C
Toxicity: See Boron Compounds.
Fire Hazard: Slight, by chemical reaction; an oxidizer. Practically non-hazardous unless mixed with highly combustible or reactive organic compounds (Section 6).
Storage and Handling: Section 7

SODIUM PERBORSILICATE
Description: White powder.
Composition: Sodium borate, sodium silicate and hydrogen peroxide.
Toxicity: See Silicates and Boron Compounds.
Fire Hazard: Slight, by chemical reaction; can react with reducing materials (Section 6).
Storage and Handling: Section 7

SODIUM PERCHLORATE
Description: Colorless, deliquescent crystals.
Formula: $NaClO_4$
Constants:
Mol. Wt. 122.45
M. P. 482°C (decomp.)
B. P. Decomposes
For other properties, see Perchlorates.

SODIUM PERMANGANATE
Description: Purple to reddish-black crystals or powder.
Formula: $NaMnO_4$
Constants:
Mol. Wt. 141.93
M. P. Decomposes
Toxicity: See Manganese Compounds.
Fire Hazard: Moderate, by chemical reaction; a strong oxidizer (Section 6).
Disaster Control: Dangerous; will react vigorously with combustible materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

SODIUM PEROXIDE
Synonyms: Sodium dioxide; sodium superoxide; sodium binoxide.
Description: Yellowish, white powder, turning yellow when heated.
Formula: Na_2O_2
Constants:
Mol. Wt. 77.99
M. P. Decomposes @460°C
B. P. Decomposes
Density 2.805
Toxicity: Highly toxic. See Sodium Hydroxide.
Fire Hazard: Dangerous, by chemical reaction; a powerful oxidizing agent. See Peroxides, Inorganic.
To Fight Fire: Carbon dioxide or dry chemical. Combustible materials ignited by contact with sodium peroxide should be smothered with soda ash, salt or dolomite mixtures. Chemical

fire extinguishers should not be used. If the fire cannot be smothered, it should be flooded with large quantities of water with a hose (Section 6).
Explosion Hazard: Moderate, by chemical reaction with water, acids, powdered metals, etc.
Disaster Control: Dangerous; will react with water or steam to produce heat and toxic fumes; can react vigorously with reducing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

SODIUM PEROXYCHROMATE
Description: Orange plates.
Formula: Na_3CrO_8
Constants:
Mol. Wt. 249.00
M. P. Decomposes @115°C
Toxicity: Highly toxic. See Chromium Compounds.
Fire Hazard: Moderate, by chemical reaction; a strong oxidizer (Section 6).
Disaster Control: Dangerous; will react vigorously with combustible materials.
Storage and Handling: Section 7

SODIUM PHENOBARBITAL
Description: White crystals.
Formula: $NaC_{12}H_{11}N_2O_3$
Constant:
Mol. Wt. 254.22
Toxicity: See Barbiturates.

SODIUM 1-PHENOL-4-SULFONATE
Description: Colorless, slightly efflorescent granules.
Formula: $NaC_6H_4(OH)SO_3 \cdot 2H_2O$
Constants:
Mol. Wt. 232.20
B. P. Decomposes
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

SODIUM PHENOXIDE
Description: White, deliquescent, crystalline needles.
Formula: $NaOC_6H_5$
Constant:
Mol. Wt. 116.10
Toxicity: Highly toxic. See Phenol and Sodium Hydroxide.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes.
Storage and Handling: Section 7

SODIUM PHENYLACETATE
Description: Dry powder.
Formula: $C_6H_5CH_2COONa$
Constant:
Mol. Wt. 158.1
Toxicity: Details unknown. See also Phenol.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

SODIUM o-PHENYLPHENATE
Description: Crystals or practically white flakes.
Formula: $NaOC_6H_4C_6H_5$
Constant:
Mol. Wt. 192.2
Toxicity: Details unknown; a fungicide. See also Phenol.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.
Storage and Handling: Section 7

SODIUM o-PHENYLPHENOLATE.
See Sodium o-Phenylphenate.

SODIUM PHOSPHIDE
Description: Red crystals.
Formula: Na_3P
Constants:
Mol. Wt. 100.0
M. P. Decomposes
For other properties, see Phosphides.

SODIUM PHOSPHOALUMINATE.
See Sodium Aluminum Phosphate.

SODIUM PICRAMATE
Description: Yellow, water-soluble salt.

Formula: $NaOC_6H_2(NO_2)_2NH_2$
Constant:
Mol. Wt. 221.00
For other properties, see Picrates and Explosives, High.

SODIUM PICRAMATE (WET WITH 20% WATER)

Shipping Regulations: Section 11.
I.C.C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

SODIUM POLONIDE

Description: Solid, radioactive material.
Formula: Na_2Po
Constant:
Mol. Wt. 256
Toxicity: See Polonium.
Radiation Hazard: See Polonium.

SODIUM 3-PYRIDINE SULFONATE

Description: Yellowish-white powder.
Formula: $C_5H_4NO_3SNa$
Constant:
Mol. Wt. 181.2
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur and nitrogen.
Storage and Handling: Section 7

SODIUM PYROPHOSPHATE PEROXIDE

Description: White powder.
Formula: $Na_4P_2O_7 \cdot 2H_2O_2$
Constant:
Mol. Wt. 334
Toxicity: See Sodium Phosphate and Hydrogen Peroxide.
Fire Hazard: Slight, by chemical reaction; an oxidizing material; may ignite upon intimate contact with combustible matter (Section 6).
Storage and Handling: Section 7

SODIUM PYROVANADATE

Description: Colorless, hexagonal plates.
Formula: $Na_4V_2O_7$
Constants: Mol. Wt. 305.89
M. P. 632 - 654°C
Toxicity: See Vanadium Compounds.

SODIUM SARCOSINATE

Synonym: Sodium N-Methylamine acetate.
Description: Clear liquid.
Formula: $HN(CH_3)CH_2COONa$
Constants:
Mol. Wt. 111.1
Vap. D. 3.83
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: U
Chronic Local: Irritant 2
Chronic Systemic: U
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

SODIUM SELENATE

Description: Colorless rhombic crystals.
Formula: Na_2SeO_4
Constants:
Mol. Wt. 188.95
Density 3.098
For other properties, see Selenium Compounds.

SODIUM SELENIDE

Description: White to red deliquescent crystals.
Formula: Na_2Se
Constants:
Mol. Wt. 124.95
M. P. > 875°C
Density 2.625 @10°C
For other properties, see Selenides.

SODIUM SELENITE

Description: White crystals.
Formula: $Na_2SeO_3 \cdot 5H_2O$
Constant:
Mol. Wt. 263.04
For other properties, see Selenium Compounds.

SODIUM SESQUISILICATE, ANHYDROUS

Description: Crystals.
Formula: $Na_6Si_2O_7$
Constant:
Mol. Wt. 306.1
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3
Acute Systemic: U
Chronic Local: Irritant 2
Chronic Systemic: U
Personnel Protection: Section 3

Personal Hygiene: Section 3
Shipping Regulations: Section 11.
MCA warning label

SODIUM SESQUISILICATE, HYDRATED
Description: Crystals.
Formula: $Na_3HSiO_4 \cdot 5H_2O$
Constant:
Mol. Wt. 252.2
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2
Acute Systemic: U
Chronic Local: Irritant 2
Chronic Systemic: U
Personnel Protection: Section 3
Personal Hygiene: Section 3

SODIUM SILICATE
Synonym: Water glass.
Description: Amorphous or colorless, deliquescent crystals.
Formula: $Na_2O \cdot xSiO_2 (x = 2\text{-}5)$
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1
Acute Systemic: U
Chronic Local: Irritant 1
Chronic Systemic: U
Personal Hygiene: Section 3

SODIUM SILICOFLUORIDE. See Sodium Fluosilicate.

SODIUM SULFHYDRATE. See Sodium Hydrosulfide.
MCA warning label.

SODIUM SULFIDE
Synonym: Sodium monosulfide.
Description: Amorphous, yellow-pink or white, deliquescent crystals.
Formula: Na_2S
Constants:
Mol. Wt. 78.06
M. P. 1180°C
Density 1.856 @14°C
For other information, see Sulfides.
Shipping Regulations: Section 11.
I. C. C. Classification:
Flammable solid; yellow label.
Coast Guard Classification:
Inflammable solid; yellow label (fused or concentrated, ground or not ground;- may be chipped, flaked or broken).
MCA warning label.

SODIUM SULFITE
Description: Hexagonal prisms or white powder.
Formula: Na_2SO_3
Constants:
Mol. Wt. 126.06
B. P. Decomposes
Density 2.633 @15.4°C
For other properties, see Sulfites.

SODIUM SULFOCYANIDE
Synonyms: Sodium sulfocyanate; sodium rhodanate; sodium rhodanide; sodium thiocyanate.
Description: Colorless, deliquescent crystals or white powder.
Formula: NaCNS
Constants:
Mol. Wt. 81.08
M. P. 287°C
Toxicity: See Thiocyanides.
Disaster Control: See Thiocyanides.
Storage and Handling: Section 7

SODIUM TELLURATE
Description: Hexagonal plates or white powder.
Formula: $Na_2TeO_4 \cdot 2H_2O$
Constants:
Mol. Wt. 273.64
M. P. Decomposes
B. P. Decomposes
For other properties, see Tellurium Compounds.

SODIUM TELLURITE
Description: White powder.
Formula: Na_2TeO_3
Constant:
Mol. Wt. 221.60
For other properties, see Tellurium Compounds.

SODIUM TETRABORATE
Synonym: Sodium borate.
Description: White crystals.
Formula: $Na_2B_4O_7$
Constants:
Mol. Wt. 201.27
M. P. 741°C
B. P. 1575°C (decomp.)
Density 2.367
Toxicity: See Boron Compounds.

SODIUM 2, 3, 4, 6-TETRACHLOROPHENATE

Description: Buff to light brown crystals or flakes.
Formula: C_6HCl_4ONa
Constant:
Mol. Wt. 253.9
For other properties, see Chlorophenols.
Storage and Handling: Section 7

SODIUM 2, 3, 4, 6-TETRACHLOROPHENOLATE

Description: Buff to brown flakes.
Formula: $Cl_4C_6HONa \cdot H_2O$
Constants:
Mol. Wt. 271.9
Vap. D. 9.4
Toxicity: Details unknown; used as fungicide.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chloride, oxides of sodium, etc.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

SODIUM TETRAHYDROGEN o-TELLURATE

Description: Hexagonal plates.
Formula: $Na_2H_4TeO_6$
Constants:
Mol. Wt. 273.64
M. P. Decomposes
B. P. Decomposes
For other properties, see Tellurium Compounds.

SODIUM TETRASULFIDE

Description: Yellow, cubic, hygroscopic crystals.
Formlula: Na_2S_4
Constants:
Mol. Wt. 174.26
M. P. 275°C
B. P. Decomposes
For other properties, see Sulfides.

SODIUM THIOARSENATE

Description: Monoclinic, yellow crystals.
Formula: $Na_3AsS_4 \cdot 8H_2O$
Constants:
Mol. Wt. 416.29
M. P. Decomposes
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur and arsenic.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

SODIUM THIOCYANATE. See Sodium Sulfocyanide.

SODIUM THIOGLYCOLATE

Description: Hygroscopic crystals.
Formula: $HSCH_2COONa$
Constant:
Mol. Wt. 114.1
Toxicity: See Sulfides. This material yields hydrogen sulfide on decomposition. The literature contains the report of a death attributed to the absorption of toxic decomposition products from the use of this material in a permanet waving solution.
For other properties, see Sulfides.

SODIUM THIOSULFATE

Synonym: Hypo.
Description: Moncclinic colorless, odorless crystals.
Formula: $Na_2S_2O_3 \cdot 5H_2O$
Constants:
Mol. Wt. 248.2
M. P. 48°C (rapid heating)
Density 1.69
Toxicity: See Thiosulfates. Large doses internally have a cathartic action.
Disaster Control: See Thiosulfates.

SODIUM p-TOLUENESULFONCHLORAMINE

Synonyms: Tolamine; tochlorine; chlorazine.
Description: White or slightly yellow crystals.
Formula: $CH_3C_6H_4SO_2NNaCl \cdot 3H_2O$
Constant:
Mol. Wt. 281.70
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: See Hypochlorites.

Personal Hygiene: Section 3
Storage and Handling: Section 7

SODIUM TRICHLOROPHENATE-2,4,5
Description: Crystals or buff to light brown flakes.
Formula: $Cl_3C_6H_2ONa$
Constant:
Mol. Wt. 219.5
Toxicity: See Chlorophenols.
Disaster Control: See Chlorophenols.
Storage and Handling: Section 7

SODIUM-2,4,5-TRICHLOROPHENOLATE
Description: Buff to brown flakes.
Formula: $Cl_3C_6H_2ONa \cdot \frac{1}{2}H_2O$
Constants:
Mol. Wt. 246.4
Vap. D. 8.5
Toxicity: Details unknown; used as fungicide.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides and oxides of sodium.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

SODIUM TRIMETHOXYBOROHYDRIDE
Description: Microcrystalline, fine white powder and white to grayish lumps.
Formula: $NaBH(OCH_3)_3$
Constants:
Mol. Wt. 127.9
M. P. 230°C (decomp. and evolves methyl borate)
Density 1.24
Toxicity: See Boron Compounds and Hydrides.
Fire Hazard: Moderate, by chemical reaction. Reacts with moisture to liberate hydrogen. See also Hydrides (Section 6).
Explosion Hazard: Moderate. See Hydrides.
Disaster Control: Dangerous. See Hydrides.

SODIUM TRIPOLYPHOSPHATE
Description: Crystals.
Formula: $Na_5P_3O_{10}$
Constant:
Mol. Wt. 367.93
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1
Acute Systemic: Ingestion 2
Chronic Local: U
Chronic Systemic: U
Toxicology: Ingestion of large doses of sodium phosphates causes cartharsis. Sodium meta- and pyro-phosphates can cause hemorrhages from the intestine if taken internally in large doses.
Personal Hygiene: Section 3

SODIUM TUNGSTATE
Description: White rhombic crystals.
Formula: Na_2WO_4
Constants:
Mol. Wt. 293.91
M. P. 698°C
Density 4.179
Toxicity: See Tungsten Compounds.

SODIUM URANATE
Synonym: Sodium m-uranate.
Description: Gray, yellow or red plates or rhombic prisms or powder.
Formula: Na_2UO_4
Constant:
Mol. Wt. 348.06
Toxicity: See Uranium.

SODIUM URANYL ACETATE
Description: Tetragonal, yellow crystals.
Formula: $NaUO_2(C_2H_3O_2)_3$
Constants:
Mol. Wt. 470.20
Density 2.56
Toxicity: See Uranium.

SODIUM URANYL CARBONATE
Description: Yellow crystals.
Formula: $2Na_2CO_3UO_2CO_3$
Constants:
Mol. Wt. 542.09
M. P. Decomposes @400°C
Toxicity: See Uranium.

SODIUM m-VANADATE
Description: Colorless, monoclinic, prismatic crystals or pale green, crystalline powder.
Formula: $NaVO_3 \cdot 4H_2O$

Constants:
  Mol. Wt. 194.0
  M. P. 630°C
Toxicity: See Vanadium Compounds.

SODIUM o-VANADATE
Description: Colorless, hexagonal prisms.
Formula: Na_3VO_4
Constants:
  Mol. Wt. 183.94
  M. P. 850 - 866°C
Toxicity: See Vanadium Compounds.

SODIUM ZINC URANYL ACETATE
Description: Tablets or monoclinic crystals.
Formula:
  $NaZn(UO_2)_3(C_2H_3O_2)_9 \cdot 9H_2O$
Constant:
  Mol. Wt. 1592.13
Toxicity: See Uranium.

SOLDERS
Description: Ductile, relatively low melting alloys.
Formula: Pb + Sn (from 5% Pb to 81.5% Pb)
Constant:
  Density 7.5 - 10.2 (dèpending on composition)
  M. P. 232 - 185°C
Toxicity: Fumes may be toxic on repeated inhalation. See Lead.

SOLVENTS, N.O.S. See specific solvent.
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Combustible liquid; inflammable liquid, red label.

SOMAN
Synonym: Fluoromethylpinacolyloxyphosphine oxide.
Description: Colorless liquid; evolves an odorless vapor.
Formula:
  $(CH_3)_3CCH(CH_3)OP(CH_3)(O)(F)$
Constants:
  Mol. Wt. 182.2
  B. P. 167°C
  Freezing P. −70°C
  Density 1.026 @20°C
  Vap. Press. 0.207 mm @20°C
  Vap. D. 6.33
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
  Chronic Local: U
  Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Toxicology: Hydrofluoric acid is product of hydrolysis. Very dangerous to eyes. Extremely toxic by skin absorption; it penetrates the skin rapidly but does not injure it. Death may occur after 15 minutes of exposure. It acts the same as tabun, but faster and in lower concentrations. See Fluorides.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Highly dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus and fluorides; will react with water, steam or acids to produce toxic and corrosive fumes; can react with oxidizing materials.
Ventilation Control (use high rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

SOOT
Description: A dark brown to black powdery material.
Composition: Carbon. Can contain toxic and irritant impurities.
Toxic Hazard Rating:
  Acute Local: Inhalation 1
  Acute Systemic: 0
  Chronic Local: Irritant 3; Inhalation 1
  Chronic Systemic: U
MAC: ACGIH (accepted); 50 million particles per cubic foot of air.
Toxicology: Soot is an obstructive and irritating dust, which may be carcinogenic. It has caused skin cancer. This latter property may be due to some coal tar product which adheres to the soot rather than the soot itself. The

commercial product in the form of dust has caused cancer of nasal sinuses and lunges.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1

SORBIC ACID

Synonym: 2,4-Hexadienoic acid.
Description: Colorless needles.
Formula: $CH_3CHCHCHCHCOOH$
Constants:
  Mol. Wt. 112.12
  B. P. 228°C (decomp.)
  Melting P. 134.5°C
  Flash P. 260°F (C.O.C.)
  Vap. Press. < 0.01 mm @20°C
  Vap. D. 3.87
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 1; Inhalation 1
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
To Fight Fire: Water.
Personal Hygiene: Section 3
Storage and Handling: Section 7

SOYBEAN OIL

Synonyms: Soya bean oil; chinese bean oil.
Description: Pale yellow to brownish-yellow liquid.
Composition: Glycerides of fatty acids.
Constants:
  M. P. 22.2°C
  Flash P. 540°F (C.C.)
  Autoign. Temp. 833°F
  Density 0.925
Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: Moderate.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

SPARTEINE AND COMPOUNDS

Description: Colorless oil.
Formula: $C_{15}H_{26}N_2$
Constants:
  Mol. Wt. 234.38
  B. P. 325°C @754 mm in H_2; 180 - 181°C @20 mm in air.
  Density 1.023 @20°/4°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated, it emits highly toxic fumes of nitrogen oxides.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

SPEARMINT OIL

Synonyms: Oil of crisp mint; curled mint.
Description: Colorless, yellow or greenish-yellow liquid.
Composition: 50% Carvone, 1-limonene, pinene.
Constant:
  Density 0.917 - 0.934 @25°/25°C
Toxic Hazard Rating:
  Acute Local: Allergen 1; Ingestion 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

SPECIAL FIREWORKS. See Explosives, Low.
Shipping Regulations: Section 11.
  I.C.C. Classification: Explosive B; special fireworks label.
  Coast Guard Classification: Explosive B; special fireworks label.

SPENT ACID. See Mixed Acid.
Shipping Regulations: Section 11.
  I.C.C. Classification: Corrosive liquid; white label.
  Coast Guard Classification: Corrosive liquid; white label.

SPENT OXIDE

Synonym: Gashouse tankage.
Composition: Iron sponge + 5 - 10%

of nitrogen.
Toxicity: Details unknown; can contain toxic materials.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7
Shipping Regulations Section 11.
  I. C. C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid.

SPENT SULFURIC ACID. See Sulfuric Acid.
Shipping Regulations: Section 11.
  I. C. C. Classification: Corrosive liquid; white label.
  Coast Guard Classification: Corrosive liquid; white label.

SPERMACETI

Description: A wax.
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: 0
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

SPERM OIL

Constant:
  Flash P. 428°F
  Density 0.875 - 0.884 @25/25°C
  Autoign. Temp. 586°F
Toxicity: Details unknown; probably low.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

SPINDLE OIL. See Lubricating Oil.

SPIRITS OF NITER (SWEET)

Synonym: Ethyl nitrite spirit.
Description: Pale, straw-colored liquid; fragrant, pungent odor; burning taste.
Composition: Alcohol solution 3.5 - 4.5% - $C_2H_5NO_2$
Constant:
  Density Not over 0.823 @25°C
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1
  Acute Systemic: Ingestion 1; Inhalation 1
  Chronic Local: U
  Chronic Systemic: Ingestion 1; Inhalation 1
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: Moderate, when vapors are exposed to heat or flame.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

SPIRITS OF NITROGLYCERIN

Synonym: Spirit glyceryl trinitrate.
Description: Clear, colorless liquid.
Composition: 1.0 - 1.1% glycerol trinitrate in alcoholic solution.
Constant:
  Density 0.814 - 0.820 @25°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: Ingestion 1; Inhalation 1
Fire Hazard: Dangerous, when exposed to heat or flame. See also Ethyl Alcohol (Section 6).
Explosion Hazard: See Nitroglycerine and Ethyl Alcohol. If the alcohol evaporates, the residue is nitroglycerine.
Disaster Control: Dangerous; when dried out, shock will explode it; when heated, it emits highly toxic fumes; on contact with oxidizing materials the mixture can react vigorously.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable liquid; red label.

Coast Guard Classification: Inflammable liquid; red label.

SPRENGEL EXPLOSIVES

This type of explosive is a mixture of nitrobenzene and fuming nitric acid. It is a powerful and cheap explosive and would have many uses except that it is limited by practical disadvantages. The components have to be mixed in glass shortly before the explosive is used. This requires preparation and equipment not always available at the site of the explosion. This material can be destroyed by throwing it into large quantitites of water, or possibly by burning in small quantities at a time. See Explosives, High.

SQUILL, RED

Synonym: Sea onion.
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2
  Chronic Local: U
  Chronic Systemic: U
Personal Hygiene: Section 3
Storage and Handling: Section 7

STANNIC BROMIDE

Synonyms: Tin bromide; tin tetrabromide.
Description: White, crystalline mass.
Formula: $SnBr_4$
Constants:
  Mol. Wt. 438.36
  M. P. 31°C
  B. P. 202°C @ 34 mm
  Density Liquid: 3.340 @ 35°C
  Vap. Press. 10 mm @ 72.7°C
Toxicity: Toxic. See Bromides.
Fire Hazard: Slight, by chemical reaction. Upon contact with moisture some heat is generated.
Disaster Control: Dangerous; See Bromides.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

STANNIC CHLORIDE

Synonyms: Tin chloride; tin tetrachloride.
Description: Colorless, fuming caustic liquid or crystals.
Formula: $SnCl_4$
Constants:
  Mol. Wt. 260.53
  M. P. −33°C
  B. P. 114.1°C
  Density 2.232
  Vap. Press. 10 mm @ 10°C
Toxicity: Corrosive. See Hydrochloric Acid.
Fire Hazard: Slight, by chemical reaction. Upon contact with moisture considerable heat is generated.
Disaster Control: Dangerous; hydrochloric acid is liberated on contact with moisture or heat.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

STANNIC CHROMATE

Description: Brownish-yellow, crystalline powder.
Formula: $Sn(CrO_4)_2$
Constants: Mol. Wt. 350.72
  M. P. Decomposes
Toxicity: See Chromium Compounds.

STARCH DUST

Description: White powder or granules.
Formula: $(C_6H_{10}O_5)_n$
Toxic Hazard Rating:
  Acute Local: Allergen 1; Inhalation 1
  Acute Systemic: Ingestion 1; Inhalation 1
  Chronic Local: Allergen 1
  Chronic Systemic: Inhalation 1
Fire Hazard: Moderate, when exposed to flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

STEARIC ACID

Synonym: Octadecanoic acid.
Description: White, amorphous solid.
Formula: $CH_3(CH_2)_{16}COOH$
Constants:
  Mol. Wt. 284.47

M. P. 69.3°C
B. P. 383°C
Flash P. 385°F (C.C.)
Density 0.847
Autoign. Temp. 743°F
Vap. Press. 1 mm @173.7°C
Vap. D. 9.80
Toxicity: Slight.
Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: Yes
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

STEARYL ALCOHOL

Synonym: 1-Octadecanol.
Description: Colorless solid or flakes.
Formula: $C_{18}H_{37}OH$
Constants:
Mol. Wt. 270.5
M. P. 58°C
B. P. 202°C @10 mm
Density 0.8124 @59°/4°C
Toxicity: See Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride.
Storage and Handling: Section 7

STEEL WOOL

Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: 0
Chronic Local: U
Chronic Systemic: 0
Personal Hygiene: Section 3

STIBINE. See Antimony Hydride.

STODDARD SOLVENT

Synonym: Safety solvent.
Description: Clear, colorless liquid.
Constants:
B. P. 300 - 400°F
Flash P. 100 - 110°F
Density 1.0
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 2; Inhalation 1
Acute Systemic: Ingestion 1; Inhalation 1
Chronic Local: Irritant 1
Chronic Systemic: U
MAC: ACGIH (accepted); 500 parts per million in air.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 1.1 - 6%
Disaster Control: Moderate; when heated to decomposition, it emits acrid fumes and may explode; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations Section 11.
Coast Guard Classification: Combustible liquid.

STOVE POLISH, LIQUID

Constant:
Flash P. Less than 80°F
Toxicity: Variable.
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Combustible liquid; inflammable liquid, red label.

STRAW

Toxic Hazard Rating:
Acute Local: Allergen 1; Inhalation 1
Acute Systemic: Inhalation 1
Chronic Local: Irritant 1; Allergen 1; Inhalation 1
Chronic Systemic: Inhalation 1
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water (Section 6).
Spontaneous Heating: Yes, espically when damp.
Explosion Hazard: Moderate, in the form of dust, when exposed to flame.

Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Hazardous article.

STRAW OIL

Synonym: Lubricating oil.
Constant:
Flash P. 315 - 361 °F
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

STRONTIUM

Description: Pale yellow, soft metal.
Formula: Sr
Constants:
At. Wt. 87.63
B. P. 1150 °C
Freezing P. 752 °C
Density 2.6
Vap. Press. 10 mm @ 898 °C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: 0
Chronic Local: Irritant 1
Chronic Systemic: 0
Radiation Hazard (Section 5): Artificial isotope Sr^{89}, half-life: 53 days; emits beta particles of 1.5 mev. The permissible levels are: In body: 2 microcuries; in air: 2×10^{-8} microcurie per milliliter; in water: 2×10^{-5} microcurie per milliliter. Hazard Rating, Class II (National Bureau of Standards Handbook No. 42).

Sr^{89} and Sr^{90} are hazardous because of the marked bone-seeking properties of strontium isotopes. They will replace calcium in the normal bone structure and act as a source of internal radiation to the blood-forming organs. These isotopes are among the most hazardous handled in laboratory or plant operations. Extreme precaution must be taken to prevent exposure to them.

Artificial isotope Sr^{90}, half-life: 28 years; emits beta particles of 0.54 mev. The permissible levels are: In body: 1 microcurie; in air: 2×10^{-10} microcurie per milliliter; in water: 8×10^{-7} microcurie per milliliter.

Sr^{90} exists in equilibrium with its daughter, Y^{90}. The permissible levels are given for the equilibrium mixture. See Sr^{89} for discussion of hazard.

Hazard Rating, Class III (National Bureau of Standards Handbook No. 42).

Fire Hazard: Moderate, in the form of dust, when exposed to flame. See also Powdered Metals (Section 6).
Explosion Hazard: Moderate, in the form of dust, by chemical reaction. Reacts with water to evolve hydrogen.
Disaster Control: Highly dangerous in form of radioactive isotopes; it will react with water or steam to produce heat and hydrogen; on contact with oxidizing materials, it can react vigorously.
Personal Hygiene: Section 3
Storage and Handling: Section 7

STRONTIUM ACID o-ARSENATE

Description: Rhombic needles.
Formula: $SrHAsO_4 \cdot H_2O$
Constants:
Mol. Wt. 245.56
M. P. $-H_2O$ @ 125 °C
Density 3.606 @ 15 °C
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

STRONTIUM ARSENITE

Synonym: Strontium o-arsenite.
Description: White powder.
Formula: $Sr_3(AsO_3)_2 \cdot 4H_2O$
Constant:
Mol. Wt. 580.77
Toxicity: Highly Toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
First Aid: Section 1
Storage and Handling: Section 7

Shipping Regulations: Section 11
I. C. C. Classification: Poison B; Poison label.
Coast Guard Classification: Poison B; poison label.

STRONTIUM BROMATE

Description: Monoclinic, colorless-yellowish, hygroscopic crystals.
Formula: $Sr(BrO_3)_2 \cdot H_2O$
Constants:
Mol. Wt. 361.48
M. P. $-H_2O$ @120°C
B. P. Decomposes @240°C
For other properties see Bromates.

STRONTIUM BROMIDE

Description: White, hygroscopic needles.
Formula: $SrBr_2$
Constants:
Mol. Wt. 247.46
M. P. 643°C
B. P. Decomposes
Density 4.216 @24°C
For other properties, see Bromides.

STRONTIUM CHLORATE

Description: White crystalline powder.
Formula: $Sr(ClO_3)_2$
Constants:
Mol. Wt. 254.54
M. P. 120°C decomposes
Density 3.152
For other properties see Chlorates.
Shipping Regulations: Section 11
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

STRONTIUM CHLORATE, WET

See Chlorates.
Shipping Regulations: Section 11
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

STRONTIUM CHLORIDE FLUORIDE

Description: Tetragonal crystals.
Formula: $SrCl_2 \cdot SrF_2$
Constants:
Mol. Wt. 284.17
M. P. 962°C
Density 4.18
Toxicity: Highly toxic. See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

STRONTIUM CHROMATE

Description: Monoclinic, yellow crystals.
Formula: $SrCrO_4$
Constants:
Mol. Wt. 203.64
Density 3.895 @15°C
For other properties see Chromium Compounds.

STRONTIUM COMPOUNDS

Toxicity: The strontium ion has a low order of toxicity. It is chemically and biologically similar to calcium. The oxides and hydroxides are moderately caustic materials. As with other compounds, the toxicity is generally a function of the anion.

STRONTIUM CYANIDE

Description: White, rhombic, deliquescent crystals.
Formula: $Sr(CN)_2 \cdot 4H_2O$
Constants:
Mol. Wt. 211.73
M. P. Decomposes
Highly toxic. For other properties, see Cyanides.

STRONTIUM FLUORIDE

Description: Cubic, colorless crystals or white powder.
Formula: SrF_2
Constants:
Mol. Wt. 125.63
M. P. 1190°C
Density 4.24
Toxicity: Highly toxic, see Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

STRONTIUM FLUOSILICATE

Description: Monoclinic crystals.
Formula: $SrSiF_6 \cdot 2H_2O$
Constants:
Mol. Wt. 265.72
M. P. Decomposes
Density 2.99 @17.5°C
Toxicity: See Fluosilicates.
Storage and Handling: Section 7

STRONTIUM HYDROSULFIDE

Description: Crystals.
Formula: $Sr(HS)_2$
Constants:
  Mol. Wt. 153.78
  M. P. Decomposes
For other properties, see Sulfides.

STRONTIUM HYDROXIDE

Description: White, deliquescent crystals.
Formula: $Sr(OH)_2$
Constants:
  Mol. Wt. 121.65
  M. P. 375°C
  Density 3.625
Toxicity: See Strontium Compounds.

STRONTIUM IODATE

Description: Triclinic crystals.
Formula: $Sr(IO_3)_2$
Constants:
  Mol. Wt. 437.47
  Density 5.045 @15°C
For other properties see Iodates.

STRONTIUM IODIDE

Description: Colorless plates.
Formula: SrI_2
Constants:
  Mol. Wt. 341.47
  M. P. 402°C
  B. P. Decomposes
  Density 4.549 @25°C
For other properties, see Iodides.

STRONTIUM MONOSULFIDE

Description: Cubic, light gray crystals.
Formula: SrS
Constants:
  Mol. Wt. 119.70
  Density 3.70 @15°C
For other properties see Sulfides.

STRONTIUM NITRATE

Description: White powder.
Formula: $Sr(NO_3)_2$
Constants:
  Mol. Wt. 211.65
  M. P. 570°C
  Density 2.986
For other properties, see Nitrates.
Shipping Regulations: Section 11
  I. C. C. Classification: Oxidizing material; yellow label
  Coast Guard Classification: Oxidizing material.

STRONTIUM NITRITE

Description: Hexagonal crystals.
Formula: $Sr(NO_2)_2 \cdot H_2O$
Constants:
  Mol. Wt. 197.66
  M. P. $-H_2O$ @>100°C
  B. P. Decomposes @240°C
  Density 2.408 @0°/0°C
For other properties, see Nitrites.

STRONTIUM OXALATE

Description: White, odorless, colorless, crystalline powder in water.
Formula: $SrC_2O_4 \cdot H_2O$
Constants:
  Mol. Wt. 193.67
  M. P. $-H_2O$ @150°C
Highly toxic. For other properties, see Oxalates.

STRONTIUM PERCHLORATE

Description: Colorless crystals.
Formula: $Sr(ClO_4)_2$
Constant:
  Mol. Wt. 286.54
For other properties, see Perchlorates.

STRONTIUM PERMANGANATE

Description: Cubic, purple crystals.
Formula: $Sr(MnO_4)_2 \cdot 3H_2O$
Constants:
  Mol. Wt. 379.54
  M. P. Decomposes @175°C
  Density 2.75
Toxicity: See Manganese Compounds.
Fire Hazard: Moderate; a strong oxidizer.
Disaster Control: Moderate; keep away from flammable materials.
Storage and Handling: Section 7

STRONTIUM PEROXIDE

Description: White powder.
Formula: SrO_2
Constants:
  Mol. Wt. 119.63
  M. P. Decomposes
  Density 4.56
For other properties see Peroxides, Inorganic.
Shipping Regulations: Section 11
  I. C. C. Classification: Oxidizing material; yellow label.
  Coast Guard Classification: Oxidizing material; yellow label.

STRONTIUM POTASSIUM CHLORATE

Synonym: Potassium-strontium chlorate.
Description: White, crystalline powder.
Formula: $Sr(ClO_3)_2 \cdot 2KClO_3$
Constant:
Mol. Wt. 499.67
For other properties see Chlorates.

STRONTIUM SELENATE

Description: Rhombic crystals.
Formula: $SrSeO_4$
Constants:
Mol. Wt. 230.59
Density 4.23
Toxicity: See Selenium Compounds.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

STRONTIUM SULFIDE. See Strontium Monosulfide.

STRONTIUM SULFITE

Description: Colorless crystals.
Formula: $SrSO_3$
Constants:
Mol. Wt. 167.70
M. P. Decomp.
For other properties see Sulfites.

STRONTIUM TETRASULFIDE

Description: Reddish crystals.
Formula: $SrS_4 \cdot 6H_2O$
Constants:
Mol. Wt. 324.0
M. P. 25°C
For other properties see Sulfides.

STROPHANTHIN

Synonym: K-strophanthin.
Description: White or yellowish powder; very bitter taste.
Formula: $C_{29}H_{44}O_{12} \cdot 8H_2O$
Constant:
Mol. Wt. 728.62
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3
Chronic Local: U
Chronic Systemic: Ingestion 2
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

STRYCHNINE (and Compounds)

Description: Hard, white, crystalline alkaloid; very bitter taste.
Formula: $C_{21}H_{22}N_2O_2$
Constants:
Mol. Wt. 334.40
M. P. 268°C
B. P. 270°C
Density 1.359 @18°C
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Allergen 1
Chronic Systemic: U

Toxicology: A very poisonous alkaloid. If it is taken by mouth, the time of action depends upon the condition of the stomach, that is, whether empty or full, and the nature of the food present. If taken by subcutaneous injection, the place of administration of the injection will affect the time of action. The first symptoms are a feeling of uneasiness with a heightened reflex of irritability, followed by muscular twitching in some parts of the body. With larger doses, this is followed by a sense of impending suffocation. Convulsive movements begin which have the effect of mechanically causing the patient to cry out or to shriek; then follow the characteristic spasms which set in with great violence. These are at first clonic and then tonic. There are successive attacks of spasms. With each successive attack, the symptoms become more violent, eventually resulting in death.

Treatment and Antidotes: Call a physician at once. The stomach should be washed out with potassium permanganate solution which is diluted to the color of port wine; give chloral hydrate per rectum to control convulsions. The use of apomorphine has been recommended and the use of phenobarbital on animals has proved successful. Barbiturates do not act readily. One gram of Merck's carbo medicinolis will bind 580 milligrams of strychnine. When this is available the stomach should be washed out with it

immediately. Sodium amytal has been used effectively as has sodium pentobarbital, particularly in animal experiments.
Disaster Control: Dangerous; when heated, it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Salts thereof, solid -
I.C.C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.
MCA warning label.

STYPHNIC ACID

Synonym: 2,4,6-Trinitroresorcinol.
Description: Hexagonal, yellow crystals.
Formula: $C_6H(OH)_2(NO_2)_3$
Constants: Mol. Wt. 245.1
M. P. 175.5°C
B. P. Sublimes
Density 1.829
Toxicity: See Resorcinol and Nitro Compounds of Aromatic Hydrocarbons.
For other properties see Nitrates.

STYRENE DIBROMIDE

Synonym: α-β-Dibromoethyl benzene.
Formula: $Br_2C_2H_3C_6H_5$
Constant: Mol. Wt. 264.0
Toxicity: Details unknown; an insecticide; probably quite toxic.
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of bromides.
Storage and Handling: Section 7

STYRENE (Monomer)

Synonyms: Vinylbenzene; phenylethylene; cinnamene.
Description: Colorless or yellowish, oily liquid; aromatic odor.
Formula: $C_6H_5CHCH_2$
Constants:
Mol. Wt. 104.14
B. P. 145.2°C
Flash P. 88°F (T.C.C.)
Freezing P. −30.6°C
Density 0.9074 @20°/4°C
Autoign Temp. 914°F
Vap. Press. 10 mm @30.8°C
Vap. D. 3.6
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: Irritant 2
Chronic Systemic: Ingestion 2; Inhalation 2
MAC: ACGIH (accepted); 200 parts per million in air; 850 milligrams per cubic meter of air.
Toxicology: High concentrations cause lassitude and narcosis. Concentrations of around 500 ppm are irritating to the eyes, nose and throat. Styrene causes drying and defatting of the skin leading to cracks and infections (Section 9).
Fire Hazard: Moderate, when exposed to heat or flame; can polymerize exothermically and ignite.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 1.1 - 6.1%.
Disaster Control: Dangerous. Keep away from flammable materials, and keep containers closed.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Combustible liquid.
MCA warning label.

STYRENE OXIDE

Synonym: Phenylethylene oxide.
Description: Colorless liquid.
Formula: $C_6H_5CHOCH_2$
Constants:
Mol. Wt. 120.1
B. P. 194.2°C
Flash P. 175°F (O.C.)
Freezing P. −36.7°C
Density 1.0469 @25°/4°C
Autoign Temp. 175°F (O.C.)
Vap. D. 4.14
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2

Acute Systemic: Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated, it emits acrid fumes; it can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

SUBLAMIN
Synonym: Mercury ethylenediaminesulfate.
Description: White, crystalline powder; contains approximately 43% mercury.
Formula:
$HgSO_4 \cdot 2(CH_2 \cdot NH_2)_2 \cdot 2H_2O$
Constant: Mol. Wt. 452.87
Toxicity: Highly toxic. See Mercury Compounds, Organic.
Disaster Control: See Mercury Compounds, Organic.
Storage and Handling: Section 7

SUCCINIC ACID
Synonyms: Ethylenesuccinic acid; ethylene dicarboxylic acid; butanedioic acid.
Description: Colorless crystals.
Formula: $COOH(CH_2)_2COOH$
Constants:
Mol. Wt. 118.09
M. P. 185°C
B. P. 235°C (decomp.)
Density 1.564 @15°/4°C
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials (Section 6).
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

SUCCINIC ACID ANHYDRIDE. See Succinic Anhydride.

SUCCINIC ACID PEROXIDE
Description: White powder.
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
For other properties see Peroxides, Organic.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material (wet or dry); yellow label.

SUCCINIC ANHYDRIDE
Synonyms: Butanedioic anhydride; succinic acid anhydride.
Description: Colorless needles.
Formula: $(CH_2CO)_2O$
Constants:
Mol. Wt. 100.07
M. P. 119.6°C
B. P. 261°C
Density 1.104
Vap. Press. 1 mm @92.0°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

SUCCINONITRILE
Synonyms: Butanedinitrile; ethylene cyanide.
Description: Colorless, odorless, waxy material.
Formula: $CNCH_2CH_2CN$
Constants:
Mol. Wt. 80.09
M. P. 58.1°C
B. P. 267°C
Flash P. 270°F (ASTM D92-46)
Density 1.022 @25°C

Vap. Press. 2 mm @100°C
Vap. D. 2.76
Toxicity: Highly toxic. See Cyanides.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides; it can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

SUCCINYL PEROXIDE
Description: Odorless, white, crystalline powder.
Formula: $(HOOCCH_2CH_2CO)_2O_2$
Constants:
Mol. Wt. 234.2
M. P. 127°C decomp.
For other properties see Peroxides, Organic.

SUCROSE OCTAACETATE
Description: Crystals.
Formula: $C_{12}H_{14}O_3(OOCCH_3)_8$
Constants:
Mol. Wt. 678.58
M. P. 72.3°C
B. P. 260°C @ 0.1 mm
Density 1.28 @ 20°/20°C
Toxicity: Probably low.
Fire Hazard: Slight.
Storage and Handling: Section 7

SULFAGUANIDINE
Description: Needle like crystals.
Formula: $C_7H_{10}N_4O_2S \cdot H_2O$
Constants:
Mol. Wt. 232.3
M. P. 190 - 193°C
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: U
Chronic Local: Allergen 2
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur and nitrogen.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

SULFAMIC ACID
Synonym: Amidosulfonic acid.
Description: White, crystalline solid.
Formula: H_2NSO_3H
Constants:
Mol. Wt. 97.09
M. P. 200°C (decomp.)
B. P. Decomposes
Density 2.03 @12°C
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

SULFAMIDE
Synonym: Sulfuryl amide.
Description: Rhombic plates.
Formula: $SO_2(NH_2)_2$
Constants:
Mol. Wt. 96.11
M. P. 91.5°C
B. P. Decomposes @250°C
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

SULFANILIC ACID
Synonym: o-Aminobenzene sulfonic acid.
Description: Colorless crystals.
Formula: $NH_2C_6H_4SO_3H \cdot H_2O$
Constants:
Mol. Wt. 191.2
M. P. 288°C (decomp.)
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition or on contact with acids it emits highly toxic fumes of oxides of nitrogen and sulfur.
Storage and Handling: Section 7

SULFATES

Toxicity: Variable. In general the toxic qualities of substances containing the sulfate radical is that of the material (anion) with which the sulfate (cation) is combined. See specific compound.

SULFIDES

Toxicity: Variable. The alkaline sulfides (potassium, calcium, ammonium and sodium) are similar in action to alkalies. They cause softening and irritation of the skin. If taken by mouth they are corrosive and irritant through the liberation of hydrogen sulfide and free alkali. Hydrogen sulfide is especially toxic and should be specially referred to (see Hydrogen Sulfide).

Sulfides of the heavy metals are generally insoluble and hence have little toxic action except through the liberation of hydrogen sulfide.

Fire Hazard: Moderate, when exposed to flame or by spontaneous chemical reaction. Many sulfides ignite easily in air at room temperature. Others require a higher temperature or the presence of an oxidizer. Upon contact with moisture or acids, hydrogen sulfide is evolved. Many powerful oxidizers on contact with sulfides ignite violently. See also Hydrogen Sulfide (Section 6).

Explosion Hazard: Many sulfides react violently and explosively on contact with powerful oxidizers. Hydrogen sulfide evolved can form explosive mixtures with air. See also Hydrogen Sulfide.

Disaster Control: Dangerous; when heated to decomposition, they emit highly toxic fumes of oxides of sulfur; they react with water, steam or acids to produce toxic and flammable vapors of hydrogen sulfide.

Ventilation Control (use moderate rate): Section 2

Storage and Handling: Section 7

SULFITES

Toxic Hazard Rating:
- Acute Local: Ingestion 2; Inhalation 2
- Acute Systemic: Ingestion 2; Inhalation 2
- Chronic Local: U
- Chronic Systemic: Ingestion 1; Inhalation 1

Toxicology: Fairly large doses of sulfites can be tolerated since they are rapidly oxidized to sulfates, although if swallowed they may cause irritation of the stomach by liberating sulfurous acid. In experimental animals, large doses of sodium sulfite have been shown to cause retarded growth, nerve irritation, atrophy of bone marrow, depression and paralysis.

Disaster Control: Dangerous; when heated to decomposition, they emit highly toxic fumes of sulfur dioxide; they will react with water, steam or acids to produce a toxic and corrosive material.

Personal Hygiene: Section 3

Storage and Handling: Section 7

1-SULFOCYANO-2, 4-DINITROBENZENE

Description: Powder.

Formula: $CNSC_6H_3(NO_2)_2$

Constant:
- Mol. Wt. 225.2

Toxicity: Probably toxic.

Fire Hazard: See Nitrates.

Explosion Hazard: See Nitrates.

Disaster Control: See Nitrates and Cyanides.

Storage and Handling: Section 7

SULFONATES

Toxicity: Unknown

Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, they emit highly toxic fumes of oxides of sulfur.

Storage and Handling: Section 7

SULFON ETHYL METHANE

Description: Lustrous scales.

Formula: $C_8H_{18}O_4S_2$

Constants:
- Mol. Wt. 242.4
- M. P. 74 - 76°C

Toxic Hazard Rating:
- Acute Local: U
- Acute Systemic: Ingestion 2; Inhalation 1

Chronic Local: U
Chronic Systemic: Ingestion 1; Inhalation 1
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

SULFUR

Synonyms: Brimstone; flowers of sulfur; sulfur flour.
Description: Rhombic, yellow crystals or yellow powder.
Formula: S_8
Constants:
Mol. Wt. 256.48
M. P. 112.8°C
B. P. 444.6°C
Flash P. 405°F (C.C.)
Density 2.07; liquid 1.803
Autoign. Temp. 450°F
Vap. Press. 1 mm @183.8°C
Toxicity: Very low. See Nuisance Dusts.
Radiation Hazard (Section 5): Artificial isotope S^{35}, half-life: 87 days; emits beta particles of 0.17 mev. The permissible levels are: In body: 100 microcuries; in air: 10^{-6} microcurie per milliliter; in water: 5×10^{-3} microcurie per milliliter. Hazard Rating, Class II (National Bureau of Standards Handbook No. 42).
Fire Hazard: Slight, when exposed to heat or flame or by chemical reaction with oxidizers.
Spontaneous Heating: No
To Fight Fire: Water or special mixtures of dry chemical (Section 6).
Explosion Hazard: Moderate, in the form of dust, when exposed to flame.
Disaster Control: Dangerous; when heated it burns and emits highly toxic fumes of oxides of sulfur; can react with oxidizing materials.
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Hazardous article.

SULFUR BROMIDE

Synonym: Sulfur monobromide.
Description: Red liquid.
Formula: S_2Br_2
Constants:
Mol. Wt. 223.96
M. P. −40°C
B. P. 54°C @0.2 mm
Density 2.635
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight when exposed to heat or flame.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur and bromides; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

SULFUR CHLORIDE

Synonym: Sulfur monochloride.
Description: Amber to yellowish-red, oily, fuming liquid; penetrating odor.
Formula: S_2Cl_2
Constants:
Mol. Wt. 135.03
M. P. −80°C
B. P. 138.0°C
Flash P. 245°F (C.C.)
Density 1.6885 @15.5°/15.5°C
Autoign. Temp. 453°F
Vap. Press. 10 mm @27.5°C
Vap. D. 4.66
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: Irritant 2; Inhalation 2
Chronic Systemic: U
MAC: ACGIH (accepted); 1 part per million in air; 6 milligrams per

cubic meter of air.

Toxicology: It is a fuming, corrosive liquid with a penetrating odor which is very irritating to the eyes, lungs, and mucous membranes. It decomposes on contact with water to form hydrogen chloride, thiosulfuric acid, and sulfur. These decomposition products are highly irritant. Its toxic effects are irritation of the upper respiratory tract, although the results of intoxication are usually transitory in nature. However, if hydrolysis is not complete in the upper respiratory tract, injury to the bronchioles and alveoli can result. The literature notes that concentrations of 2 to 9 ppm have been found in rubber factories and that these concentrations were observed to be mildly irritating. A concentration of 150 ppm has been stated to be fatal to mice after an exposure of only 1 minute.

Fire Hazard: Slight, when exposed to heat or flame.

Spontaneous Heating: No

To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of sulfur; will react with water or steam to produce heat and toxic and corrosive fumes; can react with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations: Section 11.

I. C. C. Classification: Corrosive liquid; white label.

Coast Guard Classification: Corrosive liquid; white label.

MCA warning label.

SULFUR DICHLORIDE

Description: Reddish-brown liquid; pungent odor.

Formula: SCl_2

Constants:

Mol. Wt. 103.0

M. P. −78°C

B. P. 59°C

Density 1.621 @15°/15°C

Vap. D. 3.55

Toxicity: Corrosive. See Sulfur Chloride.

Fire Hazard: Moderate, when exposed to heat or flame (Section 6).

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of sulfur; will react with water or steam to produce heat and toxic and corrosive fumes.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations: Section 11.

I. C. C. Classification: Corrosive liquid; white label.

MCA warning label.

SULFUR DIOXIDE

Synonym: Sulfurous acid anhydride.

Description: Colorless gas or liquid; pungent odor.

Formula: SO_2

Constants:

Mol. Wt. 64.06

M. P. −75.5°C

B. P. −10.0°C

Density Liq.: 1.434 @0°C

Vap. D. 2.264 @0°C

Vap. Press. 2538 mm @21.1°C

Toxic Hazard Rating:

Acute Local: Irritant 3; Ingestion 3; Inhalation 3

Acute Systemic: U

Chronic Local: Irritant 2; Inhalation 2

Chronic Systemic: U

MAC: ACGIH (accepted); 10 parts per million in air; 26 milligrams per cubic meter of air.

Toxicology: This gas is dangerous to the eyes, as it causes irritation and inflammation of the conjunctiva. It has a suffocating odor and is a corrosive and poisonous material. In moist air or fogs, it combines with water to form sulfurous acid, but is only very slowly oxidized to sulfuric acid (Section 4). Concentrations of 6 to 12 ppm cause immediate irritation of the nose and throat, while 0.3 to 1 ppm can be detected by the average individual possibly by taste rather than by the sense of smell. 3 ppm has an easily noticeable odor and 20 ppm is the least amount which is irritating to the eyes. 10,000 ppm is an irritant to moist areas of the skin within a few minutes of exposure.

It chiefly affects the upper respiratory tract and the bronchi. It may cause edema of the lungs or glottis, and can produce respiratory paralysis. Concentrations of less than 1 ppm are believed to be injurious to plant foliage.

This material is so irritating that it provides its own warning of toxic concentrations. 400 to 500 ppm is immediately dangerous to life and 50 to 100 ppm is considered to be the maximum permissible concentration for exposures of 30 to 60 minutes. Excessive exposure to high enough concentrations of this material can be fatal. Its toxicity is comparable to that of hydrogen chloride. However, less than fatal concentrations can be borne for fair periods of time with no apparent permanent damage. It is used as a fumigant, insecticide and fungicide.

Treatment and Antidotes: Personnel who have shown toxic symptoms when exposed to this material should immediately be removed to fresh air. If the eyes are involved, they should be irrigated with copious quantities of warm water. If the symptoms persist, call a physician.

Disaster Control: Dangerous; shock can shatter the compressed gas container, releasing the contents; will react with water or steam to produce toxic and corrosive fumes.

Ventilation Control (use moderate rate): Section 2

Storage and Handling: Section 7

Shipping Regulations: Section 11.
 I.C.C. Classification: Nonflammable gas; green label.
 Coast Guard Classification: Noninflammable gas; green gas label.

SULFUR FLUORIDE

Synonym: Sulfur monofluoride.

Description: Colorless gas.

Formula: S_2F_2

Constants:
 Mol. Wt. 102.12
 M. P. −105.5°C
 B. P. −99°C
 Density Liq.: 1.5 @−100°C

Toxicity: Toxic. See Fluorides and Hydrofluoric Acid.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of fluorides and oxides of sulfur; will react with water or steam to produce toxic and corrosive fumes.

Storage and Handling: Section 7

SULFUR HEPTOXIDE

Synonym: Per sulfur heptoxide.

Description: Viscous liquid or possibly needle-like crystals.

Formula: S_2O_7

Constants:
 Mol. Wt. 176.1
 M. P. 0°C
 B. P. Sublimes @10°C

Toxic Hazard Rating:
 Acute Local: Irritant 3; Ingestion 3; Inhalation 3
 Acute Systemic: U
 Chronic Local: U
 Chronic Systemic: U

Fire Hazard: Moderate, when exposed to heat or flame or by chemical reaction. When heated, or in contact with water or alcohol, it liberates oxygen.

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react with reducing materials.

Ventilation Control (use normal rate): Section 2

Storage and Handling: Section 7

SULFUR HEXAFLUORIDE

Description: Colorless gas.

Formula: SF_6

Constants:
 Mol. Wt. 146.06
 M. P. −56°C
 B.P. −63.8°C (sublimes)
 Density Solid: 1.67 @−20°C

Vap. Press. 760 mm @ -64°C
Vap. D. 6.16
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Inhalation 1
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (tentative); 1000 parts per million in air; 6000 milligrams per cubic meter of air.

Toxicology: This material is chemically inert in the pure state and is considered to be physiologically inert as well. However, as it is ordinarily obtainable, it can contain variable quantities of the lower sulfur fluorides. Some of these are toxic, very reactive chemically, and corrosive in nature. These materials can hydrolyze on contact with water to yield hydrogen fluoride, which is highly toxic and very corrosive. In high concentrations and when pure it may act as a simple asphyxiant.

Disaster Control: Dangerous, shock can shatter the compressed gas container, releasing the contents; when heated to decomposition, it emits highly toxic fumes of fluorides and oxides of sulfur.

Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Nonflammable gas; green label.
Coast Guard Classification: Noninflammable gas; green gas label.

SULFURIC ACID

Synonyms: Oil of vitriol; dipping acid.
Description: Colorless, oily liquid.
Formula: H_2SO_4
Constants:
Mol. Wt. 98.08
M. P. 10.49°C
B. P. 330°C
Density 1.834
Vap. Press. 1 mm @145.8°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: Irritant 2; Inhalation 2
Chronic Systemic: U
MAC: ACGIH (accepted); 0.3 parts per million in air; 1 milligram per cubic meter of air.

Toxicology: Contact with the body results in rapid destruction of tissue, causing severe burns. No systemic effects due to continual ingestion of small amounts of this material have been noted. There are systemic effects secondary to tissue damage caused by contact with it. However, repeated contact with dilute solutions can cause a dermatitis, and repeated or prolonged inhalation of a mist of sulfuric acid can cause an inflammation of the upper respiratory tract leading to chronic bronchitis. Sensitivity to sulfuric acid or mists or vapors varies with individuals. Normally 0.125 to 0.50 ppm may be mildly annoying and 1.5 to 2.5 ppm can be definitely unpleasant. 10 to 20 ppm is unbearable. Workers exposed to low concentrations of the vapor gradually lose their sensitivity to its irritant action. Inhalation of concentrated vapor or mists from hot acid or oleum can cause rapid loss of consciousness with serious damage to lung tissue. In concentrated form it acts as a powerful caustic to the skin destroying the epidermis and penetrating some distance into the skin and subcutaneous tissues, in which it causes necrosis. This causes great pain and if much of the skin is involved, it is accompanied by shock, collapse and symptoms similar to those seen in severe burns. The fumes or mists of this material cause coughing and irritation of the mucous membranes of the eyes and upper respiratory tract. Severe exposure may cause a chemical pneumonitis; erosion of the teeth due to exposure to strong acid fumes has been recognized in industry.

Treatment and Antidotes: Speed in removing this material from contact with the body is of primary importance. Start first aid at once. In all cases of contact in any form, delay can result in serious injuries and all persons injured should be referred to a physician. However, immediately give prolonged applications of running water to wash the material off the body. Remove contaminated clothing. Subject patient to a deluge type of shower if this is available. Do not attempt to neutralize the acid in contact with the skin until all areas of contact have been thoroughly irrigated with running water. Then applications of mild alkaline solutions may be in order. Shock symptoms will often be noted in cases of severe or extensive burns. In such a case, put patient on his back, keep him warm but not hot until physician arrives. Do not apply oils or ointments to burned area without instructions from a physician. If eyes are involved, they should immediately be irrigated with copious quantities of warm water for at least 15 minutes.

If the material has been taken internally, it causes burns of the mucous membrane of the throat, esophagus, and stomach. Do not attempt to induce vomiting in patients who have swallowed strong solutions of sulfuric acid. Do not give anything to an unconscious patient by mouth. If he is conscious, encourage him to wash out his mouth with copious amounts of water, then have him drink milk if it is available mixed with whites of eggs. If this is not available, have him drink as much water as possible. Get medical help.

Fire Hazard: Moderate, by chemical reaction; a powerful oxidizer; can ignite upon contact with combustibles.

Disaster Control: Dangerous; when heated, it emits highly toxic fumes; will react with water or steam to produce heat; can react with oxidizing or reducing materials.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations: Section 11.
I.C.C. Classification: Corrosive liquid; white label.
MCA warning label.

SULFURIC ACID, AROMATIC

Synonym: Elixir of vitriol.

Description: Clear, reddish-brown liquid; peculiar aromatic odor; pleasant acid taste when diluted.

Toxicity: Corrosive. See Sulfuric Acid.

Fire Hazard: Moderate, when exposed to heat or flame. See also Ethyl Alcohol and Sulfuric Acid.

Explosion Hazard: Moderate, in the form of vapor (ethyl alcohol) when exposed to flame.

Disaster Control: Dangerous. See Sulfuric Acid and Ethyl Alcohol.

Storage and Handling: Section 7

SULFURIC ACID, FUMING

Synonym: Oleum.

Description: Solution of sulfuric anhydride with 100% sulfuric acid; a heavy, oily liquid.

Formula: $H_2SO_4 + SO_3$

Constant:
Density 1.92 - 1.94

Toxicity: Corrosive. See Sulfuric Acid and Sulfur Trioxide.

Fire Hazard: Dangerous, by chemical reaction; a very powerful oxidizer; much more hazardous than sulfuric acid (Section 6).

Explosion Hazard: Moderate, by chemical reaction.

Disaster Control: Dangerous. See Sulfuric Acid and Sulfur Trioxide.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations: Section 11.
Coast Guard Classification: Corrosive liquid; white label.

SULFUR MONOCHLORIDE. See Sulfur Chloride.

Shipping Regulations: Section 11.
Coast Guard Classification: Corrosive liquid; white label.

SULFUR MONOOXYTETRACHLORIDE

Description: Dark red liquid.

Formula: S_2OCl_4
Constants:
Mol. Wt. 221.96
B. P. 60 - 61°C
Density 1.656 @0°C
Toxicity: Corrosive. See Hydrochloric Acid.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur and hydrochloric acid; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

SULFUROUS ACID

Description: Colorless liquid; suffocating sulfur odor (in solution only).
Formula: H_2SO_3
Constants:
Mol. Wt. 82.08
Density About 1.03
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: Irritant 2; Inhalation 3
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of sulfur dioxide.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

SULFUR PENTAFLUORIDE

Synonym: Disulfur decafluoride.
Description: Colorless liquid.
Formula: S_2F_{10}
Constants:
Mol. Wt. 254.12
B. P. 29°C
Freezing P. -92°C
Density 2.08 @0°/4°C
Toxicity: Highly toxic; see Fluorides.
MAC: ACGIH (proposed); 0.025 parts per million in air.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; on contact with water, steam or acids it hydrolyzes to evolve highly toxic and corrosive fumes.
Storage and Handling: Section 7

SULFUR SESQUIOXIDE

Description: Blue-green crystals.
Formula: S_2O_3
Constants:
Mol. Wt. 112.13
M. P. Decomposes @70 - 95°C
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react with oxidizing materials.
Storage and Handling: Section 7

SULFUR TETRACHLORIDE

Description: Yellow-brown liquid or gas at ordinary temperatures.
Formula: SCl_4
Constants:
Mol. Wt. 173.89
M. P. -30°C
B. P. -15°C (decomp.)
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of hydrochloric acid and oxides of sulfur; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

SULFUR TETRAFLUORIDE

Description: Gas.
Formula: SF_4
Constants:
Mol. Wt. 108.06
B. P. -40°C
M. P. -124°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Inhalation 3
Acute Systemic: U
Chronic Local: Irritant 3; Inhalation 3
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of fluorides; will react with water, steam or

acids to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

SULFUR TRIOXIDE (Alpha)

Description: Colorless crystals or liquid.
Formula: SO_3
Constants:
- Mol. Wt. 80.07
- M. P. 16.83°C
- B. P. 44.8°C
- Density 2.75; 1.925 @13°C (liquid)
- Vap. Press. 100 mm @10.5°C
- Vap. D. 2.76

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: U
- Chronic Local: Irritant 2; Inhalation 2
- Chronic Systemic: U

Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of sulfur; will react with water or steam to produce heat and toxic and corrosive fumes of sulfuric acid.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

SULFUR TRIOXIDE (Beta)

Description: Silky, fibrous, needle-like crystals.
Formula: $(SO_3)_2$
Constants:
- Mol. Wt. 160.1
- M. P. 62.2°C
- B. P. 44.6°C (sublimes @50°C)
- Density 1.97 (as liquid)
- Vap. Press. 100 mm @14.3°C
- Vap. D. 5.52

Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: U
- Chronic Local: Irritant 2; Inhalation 2
- Chronic Systemic: U

Disaster Control: Dangerous; when heated, it emits highly toxic fumes of oxides of sulfur; will react with water or steam to produce heat and toxic and corrosive fumes of sulfuric acid.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

SULFUR TRIOXIDE, STABILIZED

See Sulfur Trioxide.
Shipping Regulations: Section 11.
- I. C. C. Classification: Corrosive liquid; white label.
- Coast Guard Classification: Corrosive liquid; white label.

SULFUR TRIOXYTETRACHLORIDE

Description: White crystals.
Formula: $S_2O_3Cl_4$
Constants: Mol. Wt. 254.0
- M. P. 57°C (decomp.)

Toxicity: Details unknown. This material readily decomposes into toxic compounds and should be considered highly toxic.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur and chlorides; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

SULFURYL CHLORIDE

Synonyms: Chlorosulfuric acid; sulfonyl chloride; sulfuric chloride; sulfuric oxychloride.
Description: Colorless liquid; pungent odor.
Formula: SO_2Cl_2
Constants:
- Mol. Wt. 135.0
- M. P. −54.1°C
- B. P. 69.1°C
- Density 1.6674
- Vap. Press. 100 mm @17.8°C
- Vap. D. 4.65

Toxicity: Corrosive. See Sulfuric Acid and Hydrochloric Acids which are formed upon hydrolysis.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of sulfur; will react with water or steam to produce heat, toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Corrosive liquid; white label.
MCA warning label

SULFURYL CHLORIDE FLUORIDE

Description: Colorless gas.
Formula: SO_2ClF
Constants:
Mol. Wt. 118.52
M. P. −124.7°C
B. P. 7.1°C
Toxicity: Toxic. See Sulfuric Acid and Fluorides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides, fluorides and oxides of sulfur; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

SULFURYL FLUORIDE

Description: Colorless gas.
Formula: SO_2F_2
Constants: Mol. Wt. 102.07
M. P. −120°C
B. P. −52°C
Density 3.72 g/l
Toxicity: Toxic. See Fluorides and Sulfuric Acid.
Disaster Control: Dangerous; shock can shatter the compressed gas container, releasing the contents; when heated to decomposition, it emits highly toxic fumes of fluorides and oxides of sulfur; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

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Synonym: Cyanodimethylaminoethoxy phosphine oxide.
Description: A colorless to brownish liquid.
Formula: $CH_3CH_2OPO(CN)[N(CH_3)_2]$
Constants:
  Mol. Wt. 162.1
  B. P. Decomposes @238°C
  Freezing P. −49.4°C
  Flash P. 172°F
  Density 1.073 @25°C
  Vap. Press. 0.07 @25°C
  Vap. D. 5.63
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
  Chronic Local: U
  Chronic Systemic: U
Toxicology: A nerve gas. Vapor does not penetrate skin; liquid does so rapidly. The primary physiological action is on the sympathetic nerve system, causing a vasoparesis. Vapors when inhaled can cause nausea, vomiting and diarrhea, which can be followed by muscular twitchings and convulsions.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Highly dangerous; it emits highly toxic fumes; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

TAGAYASAN

Description: A wood.
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight, in the form of dust when exposed to heat or flame (Section 6).
Explosion Hazard: Slight, in the form of dust, when exposed to flame.
Personal Hygiene: Section 3
Storage and Handling: Section 7

TALC

Synonyms: Talcum, French chalk; steatite.
Description: White to grayish-white fine, odorless powder.
Formula: Powdered native hydrous magnesium silicate.
Toxic Hazard Rating:
  Acute Local: Inhalation 1
  Acute Systemic: U
  Chronic Local: Inhalation 2
  Chronic Systemic: Inhalation 3
MAC: ACGIH (accepted); 20 million particles per cubic foot of air.
Caution: Can produce a form of pulmonary fibrosis (talc pneumoconiosis).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

TALL OIL

Synonyms: Liquid rosin; tallol.
Description: Flammable liquid, dark brown, acrid odor.
Composition: Rosin acids, oleic and linoleic acids.
Constant:
  Density 0.95 - 1.0
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

TALLOW

Description: A solid fat.
Constants:
  M. P. 88 - 100°F

Flash P. 509°F (C.C.)
Density 0.895
Toxicity: Low.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: Yes
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TALLOW OIL

Synonym: Oleo oil.
Constants: M. P. 42.8°C
Flash P. 492°F (C.C.)
Density 0.914
Autoign Temp. 980°F
Toxicity: Unknown.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Spontaneous Heating: Yes.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TANKAGE FERTILIZER

Toxicity: Details unknown; may contain ammonia, sulfides and other irritants.
Fire Hazard: Moderate, when exposed to heat or flame. Presence of or absence of moisture can contribute to spontaneous heating. Avoid storage before cooling or extremes of moisture content; can react with oxidizing materials.
Spontaneous Heating: Variable.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Hazardous (8% or more moisture); inflammable solid (8% or less moisture), yellow label.

TANKAGE, ROUGH AMMONIATE.

See Tankage Fertilizer.
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

TANKS, EMPTY

Shipping Regulations: Section 11.
I.C.C. Classification: See Section 11, §73.29.
Coast Guard Classification: Hazardous article.

TANNIC ACID

Synonyms: Tannin, gallotannic acid.
Description: Yellowish-white, brown, bulky powder or flakes.
Formula: $C_{76}H_{52}O_{46}$
Constants:
Mol. Wt. 1701.2
M. P. 200°C
Flash P. 390°F (O.C.)
Autoign. Temp. 980°F
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: Irritant 2
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Water
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

TANSY OIL

Synonym: Oil of tansy.
Description: Yellowish liquid; strong odor.
Constant:
Density 0.925 - 0.955 @ 15°/15°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 1
Chronic Local: U
Chronic Systemic: U
Disaster Control: Moderately dangerous; when heated, it emits acrid fumes.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

TANTALUM

Description: Cubic, gray-black, metallic crystals or powder.
Formula: Ta
Constants:
At. Wt. 180.88
M. P. 3027°C
B. P. Approx. 4100°C
Density Metal: 16.6; Powder: 14.5

Toxicity: Details unknown.
Toxicology: Some industrial skin injuries from tantalum have been reported. However, systemic industrial poisoning is apparently not known. So far experimental work has indicated that tantalum does not produce any unfavorable effects upon the body. Tantalum metal embedded in the abdominal wall and in bones of dogs caused no physiological disturbances, and so far the use of tantalum in human surgery has received favorable comment.
Radiation Hazard (Section 5): Artificial isotope Ta^{182}, half-life: 120 days; emits beta particles of 0.5 mev and many gamma rays between 0.05 -1.2 mev. The gamma radiation of 1.1 - 1.2 mev is strong in this isotope, making it an excellent source for radiography.
Fire Hazard: Moderate, in the form of dust when exposed to heat or flame or by chemical reaction with oxidizing agents. See also Powdered Metals.

TANTALUM BROMIDE
Description: Yellow crystals.
Formula: $TaBr_5$
Constants:
Mol. Wt. 580.46
M. P. 240°C
B. P. 320°C
Density 4.67
Toxicity: See Bromides.
Disaster Control: See Bromides.

TANTALUM CHLORIDE
Description: Light yellow, crystalline powder.
Formula: $TaCl_5$
Constants:
Mol. Wt. 358.17
M. P. 221°C
B. P. 242°C
Density 3.68 @27°C
Toxicity: Details unknown.
Disaster Control: See Chlorides.

TANTALUM FLUORIDE
Description: Colorless crystal.
Formula: TaF_5
Constants:
Mol. Wt. 275.88
M. P. 96.8°C
B. P. 229.5°C
Density 4.74
Vap. Press. 100 mm @130°C
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

TAR ACIDS (COAL). See Phenol and Cresol.

TAR, DEHYDRATED
Description: Dark brown, thick, viscid liquid.
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: U
Chronic Local: Irritant 3
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Disaster Control: Moderately dangerous; when heated, it emits toxic fumes.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

TAR DUST
Toxic Hazard Rating:
Acute Local: Irritant 2; Inhalation 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Caution: Irritating to the eyes.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Personnel Protection: Section 3
Personal Hygiene: Section 3

TAR, LIQUID
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: U
Chronic Local: Irritant 3
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Moderately dangerous; when heated it emits toxic fumes.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.

Coast Guard Classification: Combustible liquid; inflammable liquid, red label.

TARTARIC ACID

Synonym: Racemic acid.
Description: White crystals.
Formula: $HOOC(CHOH)_2COOH$
Constants:
- Mol. Wt. 150.09
- M. P. 168-170 °C
- Flash P. 410 °F (O. C.)
- Density 1.76
- Autoign. Temp. 802 °F

Toxic Hazard Rating:
- Acute Local: Irritant 1; Ingestion 1; Inhalation 1
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Water (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

TAR, WATER GAS

Toxic Hazard Rating:
- Acute Local: Irritant 2
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Slight, when exposed to heat (Section 6).
Disaster Control: Moderately dangerous; when heated, it emits acrid fumes.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 3

TEAK

Description: A wood.
Toxic Hazard Rating:
- Acute Local: Irritant 1; Allergen 1; Inhalation 1
- Acute Systemic: U
- Chronic Local: Allergen 1
- Chronic Systemic: U

Fire Hazard: Moderate, in the form of dust, when exposed to heat or flame (Section 6).
Explosion Hazard: Slight, in the form of dust when exposed to flame. See also Dust.
Personal Hygiene: Section 3
Storage and Handling: Section 7

TEAR GAS MATERIAL, LIQUID OR SOLID, N.O.S.

Toxic Hazard Rating:
- Acute Local: Irritant 3; Inhalation 3
- Acute Systemic: Inhalation 3
- Chronic Local: U
- Chronic Systemic: U

Disaster Control: Dangerous; shock can shatter the compressed gas container, releasing the contents; it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
- I. C. C. Classification: Poison C; tear gas label.
- Coast Guard Classification: Poison C; tear gas label.

TECHNETIUM

Description: Hexagonal crystal structure.
Formula: Tc
Constant:
- At. Wt. 99

Toxicity: Unknown
Radiation Hazard (Section 5):
Artificial isotope Tc^{96}, half-life: 4.3 days; emits many gamma rays between 0.31 - 1.1 mev. The permissible levels are: In body: 5 microcuries; in air: 3×10^{-6} microcurie per milliliter; in water: 3×10^{-2} microcurie per milliliter.

o-TELLURIC ACID

Description: Needles.
Formula: $H_6TeO_6 \cdot 4H_2O$
Constants:
- Mol. Wt. 301.72
- M. P. $-4H_2O$ @100 °C

Toxicity: See Tellurium Compounds.
Disaster Control: See Tellurium Compounds.
Storage and Handling: Section 7

TELLURIUM

Description: Dark gray crystalline or amorphous powder or small cakes.
Formula: Te
Constants:
- At. Wt. 127.61

Density 6.25
M. P. 452°C
B. P. 1390°C
Vap. Press. 1 mm @520°C

Toxicity: See Tellurium Compounds.

MAC: ACGIH (accepted); 0.1 milligram per cubic meter of air.

Radiation Hazard (Section 5): Artificial isotope Te^{127}, half-life: 90 days; emits beta particles of 0.7 mev and gamma rays of 0.089 mev. The permissible levels are: In body: 4 microcuries; in air: 10^{-7} microcurie per milliliter; in water: 3×10^{-2} microcurie per milliliter. Hazard Rating, Class II (National Bureau of Standards Handbook No. 42).

Artificial isotope Te^{129}, half-life: 34 days; emits gamma rays of 0.11 mev. The permissible levels are: In body: 1.3 microcuries; in air: 4×10^{-8} microcurie per milliliter; in water: 10^{-2} micorcurie per milliliter. Hazard Rating, Class II (National Bureau of Standards Handbook No. 42).

Fire Hazard: Moderate, in the form of dust when exposed to heat or flame or by chemical reaction with oxidizing agents. See also Powdered Metals.

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

TELLURIUM COMPOUNDS

Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3

Toxicology: All tellurium compounds are probably toxic, especially those that are soluble. Tellurium compounds can be absorbed into the body through the skin, by ingestion, or by inhalation of the finely divided particles or of vapors, and they are excreted in the exhaled breath, sweat, urine and feces. The most pronounced physiological effects from the inhalation of this material are a dry mouth and metallic taste, inhibition of sweat, languor, somnolence, loss of appetite, salivation, nausea, vomiting, a garlic-like odor of the breath, and constipation.

Disaster Control: Dangerous; when heated or on contact with acid or acid fumes, they emit highly toxic fumes.

Ventilation Control (use moderate rate): Section 2

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

TELLURIUM DIBROMIDE

Description: Needles.

Formula: $TeBr_2$

Constants:
Mol. Wt. 287.44
M. P. 210°C
B. P. 339°C

Toxicity: Highly toxic. See Tellurium Compounds and Bromides.

Disaster Control: See Tellurium Compounds and Bromides.

Storage and Handling: Section 7

TELLURIUM DICHLORIDE

Description: Crystals or amorphous, unstable.

Formula: $TeCl_2$

Constants:
Mol. Wt. 198.52
M. P. 209 ± 5°C
B. P. 327°C
Density 7.05

Toxicity: Highly toxic. See Tellurium Compounds.

Disaster Control: Dangerous; when heated to decomposition, or on contact with acid or acid fumes, it emits highly toxic fumes of chlorides.

Storage and Handling: Section 7

TELLURIUM DIIODIDE

Description: Crystals.

Formula: TeI_2

Constants:
Mol. Wt. 381.45
M. P. Sublimes

Toxicity: Highly toxic. See Tellurium Compounds and Iodides.

Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes,

it emits highly toxic fumes of iodides and tellurium.
Storage and Handling: Section 7

TELLURIUM HEXAFLUORIDE
Description: Colorless gas.
Formula: TeF_6
Constants:
Mol. Wt. 241.61
M. P. -36°C
B. P. -35.5°C
Density 3.025 @-35.5°C
Toxicity: Highly toxic. See Fluorides and Tellurium Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of fluorides; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

TELLURIUM NITRIDE
Description: Solid.
Toxicity: Highly toxic. See Tellurium Compounds.
Explosion Hazard: Severe, when shocked or exposed to heat.
Disaster Control: Dangerous; shock will explode it; when heated or on contact with acid or acid fumes, it emits highly toxic fumes of tellurium and may explode; will react with water or steam to produce toxic fumes.
Storage and Handling: Section 7

TELLURIUM SULFIDE
Description: Amorphous powder.
Formula: TeS_2
Constant:
Mol. Wt. 191.73
Toxicity: Highly toxic. See Sulfides and Tellurium Compounds.
For other properties, see Sulfides.

TELLURIUM SULFITE
Description: Amorphous, deep red solid.
Formula: $TeSO_3$
Constants:
Mol. Wt. 207.67
M. P. Soft. 30°C
B. P. Decomposes
Toxicity: Highly toxic. See Tellurium Compounds and Sulfites.

TELLURIUM TETRAFLUORIDE
Description: White crystals.
Formula: TeF_4
Constants:
Mol. Wt. 203.61
M. P. Sublimes
Toxicity: Highly toxic. See Fluorides and Tellurium Compounds.

"TENAMINE-1"
Description: Lemon yellow, mobile liquid.
Composition: 48% N-n-butyl p-aminophenol in isopropyl alcohol.
Constants:
Density 0.89 - 0.91 @25°/25°C
Flash P. 61°F
Freezing P. -33°C
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition it emits toxic fumes; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

"TENAMINE 60"
Description: Liquid.
Composition: 20% toluene and 80% disalicylal propylene diimine.
Constants:
Freezing P. -18.3°C
Flash P. 19°F (C.C.)
Density 1.07@ 25°/25°C
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; keep away from open flame or heat; it emits toxic fumes when heated; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

TERBIUM
Description: A rare earth.
Formula: Tb
Constant:
At. Wt. 159.20
Toxicity: Unknown
Fire Hazard: Moderate, in the form of dust when exposed to heat or flame or by chemical reaction with oxidizers. See also Powdered Metals.

TERBIUM NITRATE
Description: Colorless, monoclinic needles.
Formula: $Tb(NO_3)_3 \cdot 6H_2O$
Constants:
Mol. Wt. 453.32
M. P. 89.3°C
Toxicity: Details unknown. See Nitrates.
Fire Hazard: An oxidizing agent. See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

TERPENES. See Turpentine Oil.

m-TERPHENYL
Synonyms: m-Phenyl biphenyl; benzene-1, 3-diphenyl.
Description: Colorless needles.
Formula: $(C_6H_5)_2C_6H_4$
Constants:
Mol. Wt. 230.3
M. P. 86°-87°C
B. P. 363°C
Flash P. 375°F (O. C.)
Density 1.164
Vap. P. 7.95
Toxicity: Details unknown. See Diphenyls.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

o-TERPHENYL
Synonym: 1, 2-Diphenyl benzene.
Description: A liquid.
Formula: $C_6H_4(C_6H_5)_2$
Constants:
Mol. Wt. 230.3
B. P. 332°C
Flash P. 325°F (O. C.)
Density 1.14
Vap. D. 7.95
Toxicity: Details unknown. See Diphenyls.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

p-TERPHENYL
Synonym: Benzene-1, 4 diphenyl.
Description: Liquid.
Formula: $(C_6H_5)_2C_6H_4$
Constants: Mol. Wt. 230.3
M. P. 213°C
B.P. 405°C
Flash P. 405°F (O. C.)
Density 1.236
Vap. D. 7.95
Toxicity: Details unknown. See Diphenyls.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TERPINOLENE
Synonym: 1, 4(8)-p-methadiene.
Description: Colorless liquid.
Formula: $C_{10}H_{16}$
Constants:
Mol. Wt. 136.23
B. P. 185°C
Density 0.855
Flash P. 100°F (C. C.)
Toxicity: Unknown.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous. Keep away from open flame; it can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

TESTOSTERONE
Synonym: Δ^4-Androsten-17(α)-ol-3-one.
Description: Crystals.
Formula: $C_{19}H_{28}O_2$
Constants:
Mol. Wt. 288.4
M. P. 155°C

Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
  Chronic Local: U
  Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Caution: Workers engaged in the manufacture and packaging have shown effects from this hormone. Enlargement of the breasts in male workers has been observed.
Disaster Control: Dangerous; when heated it emits toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personal Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

TETRAAMYLBENZENE

Description: Liquid.
Formula: $C_6H_2(C_5H_{11})_4$
Constants:
  Mol. Wt. 358.6
  B. P. 320°C
  Flash P. 295°F
  Density 0.89
Toxicity: Details unknown. See Benzene.
Fire Hazard: Slight, when exposed to heat or flame; it can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TETRABORANE

Synonym: Borobutane.
Description: Gas; disagreeable odor.
Formula: B_4H_{10}
Constants:
  Mol. Wt. 53.4
  M. P. -120°C
  B. P. 18°C
  Vap. Press. 580 mm @6°C
Toxicity: See Boron Hydrides.
Fire Hazard: Dangerous, by chemical reaction.
Explosion Hazard: Unknown.
Disaster Control: Highly dangerous; shock can shatter the compressed gas container, releasing the contents; when heated to decomposition it burns and emits highly toxic fumes; it can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

TETRABORIC ACID

Description: White powder.
Formula: $H_2B_4O_7$
Constant:
  Mol. Wt. 157.30
Toxicity: See Boron Compounds.

TETRABROMOETHANE. See Acetylene Tetrabromide.

TETRABUTYL THIODISUCCINATE

Description: Liquid.
Formula: $[CH_2(COOC_4H_9)CH(COOC_4H_9)]_2S$
Constants:
  Mol. Wt. 490.64
  M. P. -45°C
  B. P. 246°C @5 mm
  Flash P. 430°F (O. C.)
  Density 1.0543 @20°/20°C
  Vap. Press. 0.24 mm @200°C
  Vap. D. 16.9
Toxicity: Unknown.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous, when heated to decomposition it burns and emits highly toxic fumes of oxides of sulfur; it can react on contact with oxidizing materials.
Storage and Handling: Section 7

TETRA-n-BUTYL TITANATE

Description: Colorless liquid.
Formula: $(C_4H_9O)_4Ti$
Constants:
  Mol. Wt. 340
  M. P. <-40°C
  B. P. 206°C @10 mm
  Density 0.9951 @25°C
  Vap. D. 11.7
Toxicity: Details unknown. See Esters.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

TETRABUTYL UREA

Description: Liquid.
Formula: $(C_4H_9)_2NCON(C_4H_9)_2$
Constants:
- Mol. Wt. 284.5
- M. P. < −60°C
- B. P. 300 - 315°C
- Flash P. 200°F
- Density 0.876
- Vap. D. 9.83

Toxicity: Unknown.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

TETRACENE

Synonym: Naphthacene.
Description: Orange crystals.
Formula: $C_{18}H_{12}$
Constants:
- Mol. Wt. 228.3
- M. P. 341°C
- Density 1.35

Toxicity: Unknown.
Explosion Hazard: Moderate, when shocked.
Disaster Control: Dangerous; shock will explode it; when heated it burns and emits acrid fumes; can react on contact with oxidizing materials.
Storage and Handling: Section 7

TETRACETYLENE DICARBONIC ACID

Description: Solid.
Toxicity: Unknown.
Explosion Hazard: Severe, when shocked, exposed to heat or by chemical reaction.
Disaster Control: Highly dangerous; shock or heat will explode it.
Storage and Handling: Section 7

1, 2, 4, 5-TETRACHLOROBENZENE

Synonym: Benzene tetrachloride.
Formula: $C_6H_2Cl_4$
Constants:
- Mol. Wt. 215.9
- M. P. 47.5°C
- B. P. 245°C
- Flash P. 311°F (C. C.)
- Density 1.734
- Vap. Press. < 0.1 mm @25°C
- Vap. D. 7.4

Toxicity: Probably toxic. See Chlorinated Benzenes.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous, when heated to decomposition it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

TETRACHLORO-p-BENZOQUINONE

Formula: $C_6Cl_2O_2$
Constant:
- Mol. Wt. 175.0

Toxicity: Probably toxic. See also Quinones.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

TETRACHLORODIAMMINE PLATINUM (IV)

Description: Rhombic or hexagonal plates or needles; orange-yellow.
Formula: $[Pt(NH_3)_2Cl_4]$
Constant:
- Mol. Wt. 371.12

Toxicity: Details unknown. See Platinum Compounds.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

TETRACHLORODIFLUOROETHANE

Description: Liquid.
Formula: $C_2F_2Cl_4$
Constants:
- Mol. Wt. 203.8
- B. P. 92.8°C
- Density 1.6447 @25°C
- Vap. D. 7.03

Toxic Hazard Rating:
- Acute Local: 0
- Acute Systemic: Inhalation 2
- Chronic Local: U
- Chronic Systemic: Inhalation 1

Disaster Control: Dangerous; when heated, it emits highly toxic fumes of fluorides and chlorides.

Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

TETRACHLORODINITROETHANE
Description: Crystals.
Formula: $(CCl_2NO_2)_2$
Constants:
Mol. Wt. 257.87
B. P. Decomp. @130°C → peroxide of nitrogen
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated, it emits highly toxic fumes; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

1,1,2,2-TETRACHLOROETHANE.
See Acetylene Tetrachloride.

TETRACHLOROMETHYL ETHER
Description: Fuming liquid, pungent odor.
Formula: $O(CHCl_2)_2$
Constants:
Mol. Wt. 183.87
B. P. 145°C
Density 1.6537 @18°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated, it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

TETRACHLORONAPHTHALENE
Synonym: 1,2,3,4-Tetrachloro-1,2,3,4-tetrahydronaphthalene.
Description: Crystals.
Formula: $C_{10}H_8Cl_4$
Constants:
Mol. Wt. 269.99
M. P. 182°C
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: U
Chronic Local: Irritant 2
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Disaster Control: Dangerous; when heated, it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

2,3,4,6-TETRACHLOROPHENOL
Description: Light brown mass; strong odor.
Formula: Cl_4C_6HOH
Constants:
Mol. Wt. 231.9
M. P. 69-70°C
B. P. 288°C (with some decomp.)
Vap. Press. 1 mm @100.0°C
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: U
Chronic Local: Irritant 2
Chronic Systemic: Ingestion 3; Inhalation 3
Disaster Control: Dangerous, when heated, it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
MCA warning label.

2,4,5,6-TETRACHLOROPHENOL
Description: Brown solid; phenol odor.
Formula: C_6HCl_4OH
Constants: Mol. Wt. 231.92
M. P. 50°C
Density 1.65 @60°/4°C
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3
Disaster Control: Dangerous; when heated it emits highly toxic fumes.

Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
MCA warning label.

TETRACHLOROQUINONE

Description: Solid.
Formula: $C_6O_2Cl_4$
Constants: Mol. Wt. 245.9
M. P. 290°C
Toxicity: Details unknown. See Quinones.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

TETRACHLORORESORCINOL

Description: Crystals.
Formula: $C_6(OH)_2Cl_4$
Constant:
Mol. Wt. 247.9
Toxicity: Probably high. A seed disinfectant. See Resorcinol.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

TETRACHLOROSILANE

Description: Colorless fuming liquid.
Formula: $SiCl_4$
Constants:
Mol. Wt. 169.89
M. P. −70°C
B. P. 57.6°C
Density 1.50 @25°/25°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; shock can shatter the container, releasing the contents; when heated it emits highly toxic fumes; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

TETRACHLOROTETRAFLUOROPROPANE

Description: Liquid.
Formula: $C_3Cl_4F_4$
Constant:
Mol. Wt. 253.9
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of fluorides and chlorides.
Storage and Handling: Section 7

TETRACINE

Synonym: Guanylnitrosoaminoguanyltetrazene.
Description: Crystals.
Toxicity: Unknown
Fire Hazard: Dangerous. See Nitrates and Explosives, High.
Explosion Hazard: Severe, when shocked or exposed to heat. It is a high explosive which evolves much flame. It is used in priming compositions and sometimes in combinations with lead azide to lower the flash point of the azide.
Disaster Control: Highly dangerous! Shock will explode it; when heated to decomposition it emits highly toxic fumes of oxides of nitrogen and explodes.
Storage and Handling: Section 7

TETRADECANE

Description: Liquid.
Formula: $CH_3(CH_2)_{12}CH_3$
Constants:
Mol. Wt. 198.38
M. P. 5.5°C
B. P. 252.5°C
Flash P. 212°F
Density 0.765
Vap. Press. 1 mm @76.4°C
Vap. D. 6.83
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate in the form of vapor when exposed to flame.
Explosive Range: 0.5% (L.E.L)

Disaster Control: Moderately dangerous; when heated, it emits acrid fumes; can react with oxidizing materials.
Storage and Handling: Section 7

TETRADECANOL
Synonym: Tetradecyl alcohol.
Description: Opaque leaflets.
Formula: $C_{14}H_{29}OH$
Constants:
Mol. Wt. 214.38
M. P. 37.62°C
B. P. 264.1°C
Flash P. 285°F (O.C.)
Density 0.8355 @20°/20°C; liquid: 0.8236 @38°/4°C
Vap. Press. 0.01 mm @20°C
Vap. D. 7.39
Toxicity: Details unknown. See Alcohols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

1-TETRADECENE
Synonym: α-α-Tetradecylene.
Description: Colorless liquid.
Formula: $CH_2CH(CH_2)_{11}CH_3$
Constants:
Mol. Wt. 196.36
M. P. −12°C
B. P. 127°C @ 15 mm
Density 0.7737 @20°/4°C
Vap. D. 6.78
Toxicity: Unknown
Fire Hazard: Moderate. Can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TETRAETHANOL AMMONIUM HYDROXIDE
Description: Crystals.
Formula: $(HOCH_2CH_2)_4NOH$
Constants:
Mol. Wt. 211.18
M. P. 123°C
Vap. Press. < 0.01 mm @20°C
Vap. D. 7.28
Toxicity: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Storage and Handling: Section 7

TETRAETHOXY PROPANE
Description: Liquid.
Formula: $(C_2H_5O_2)_2CH_2H_2CH(OC_2H_5)_2$
Constants: Mol. Wt. 220.3
M. P. −90°C
B. P. 219.9°C
Flash P. 190°F (O.C.)
Density 0.9197 @20°/20°C
Vap. D. 7.58
Toxicity: Unknown
Fire Hazard: Moderate, when exexposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TETRAETHOXYSILANE
Description: Liquid.
Formula: $C_8H_{20}O_4Si$
Constants: Mol. Wt. 208.22
B. P. 165.5°C
Density 0.933 @25°/25°C
Vap. Press. 1 mm @16.0°C
Toxicity: Details unknown. See Silanes.
Storage and Handling: Section 7

TETRAETHYL DITHIONO-PYROPHOSPHATE
Toxicity: High. See Tetraethyl Pyrophosphate.
MAC: ACGIH (proposed); 0.2 milligram per cubic meter of air.
Disaster Control: Dangerous; when heated, it emits toxic fumes.
Ventilation Control (use high rate): Section 2
Storage and Handling: Section 7

TETRAETHYLENE GLYCOL
Description: Colorless to pale straw-colored liquid.
Formula: $HO(C_2H_4O)_3C_2H_4OH$
Constants:
Mol. Wt. 194.22
B. P. 327.3°C
Freezing P. −6°C
Flash P. 345°F (O.C.)
Density 1.1248 @20°/20°C
Vap. Press. 1 mm @153.9°C
Toxicity: See Glycols.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TETRAETHYLENE GLYCOL DIMETHYL ETHER
Synonym: Dimethoxytetraethylene glycol.
Description: Clear liquid; mild odor.
Formula: $CH_3(OCH_2CH_2)_4OCH_3$
Constants:
Mol. Wt. 222.3
B. P. 275.3°C
Freezing P. < −29.7°C
Flash P. 285°F (O. C.)
Density 1.013 @20°/20°C
Vap. Press. 0.01 mm @20°C
Vap. D. 7.68
Autoign. Temp. 1130°F
Toxicity: See Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TETRAETHYLENE PENTAMINE
Description: Viscous, hydroscopic liquid.
Formula:
$NH_2(CH_2CH_2NH)_3CH_2CH_2NH_2$
Constants:
Mol. Wt. 189.30
B. P. 333°C
Flash P. 325°F (O. C.)
Density 0.9980 @20°/20°C
Vap. Press. <0.01 mm @20°C
Toxicity: Details unknown. See Amines.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of oxides of nitrogen; can react with oxidizing materials.
Storage and Handling: Section 7
MCA warning label.

TETRA-2-ETHYL HEXYL TITANATE
Description: Light yellow liquid.
Formula: $Ti(OC_8H_{17})_4$
Constants:
Mol. Wt. 564
M. P. < −25°C
B. P. 194°C @0.25 mm
Density 1.0711 @25°C
Vap. D. 19.5
Toxicity: Details unknown. See Titanium Compounds.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TETRAETHYL LEAD. See Lead Tetraethyl.
Shipping Regulations: Section 11.
Coast Guard Classification: Poison B; poison label.

TETRAETHYL PYROPHOSPHATE
Description: Water-white to amber, hygroscopic liquid.
Formula: $(C_2H_5)_4P_2O_7$
Constants:
Mol. Wt. 290.20
Density 1.20
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Toxicology: The action is similar to that of parathion. Briefly, the action results in an irreversible inhibition of the cholinesterase molecules and the consequent accumulation of large amounts of acetycholine.
MAC: ACGIH (tentative); 0.05 milligram per cubic meter of air.
Disaster Control: Dangerous; when heated it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.

Coast Guard Classification:
Poison B; poison label.
MCA warning label.

TETRAETHYL PYROPHOSPHATE, COMPRESSED GAS MIXTURE
Shipping Regulations: Section 11.
I. C. C. Classification: Poison A; poison gas label.
Coast Guard Classification:
Poison A; poison gas label.

TETRAETHYL o-SILICATE. See Ethyl Silicate.

TETRAETHYL THIURAM DISULFIDE
See Bis(diethylthiocarbamyl) disulfide.

TETRAETHYL THIURAM SULFIDE
Description: Crystals.
Formula: $[(C_2H_5)_2NCS]_2S$
Constants: Mol. Wt. 264
B. P. 225 - 240°C @3 mm
Density 1.12 @20°/20°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

TETRAFLUOROETHYLENE, INHIBITED
Synonym: Perfluoroethylene.
Description: Colorless gas.
Formula: CF_2CF_2
Constants: Mol. Wt. 100.02
M. P. -142.5°C
B. P. -78.4°C
Disaster Control: Dangerous; shock can shatter the compressed gas container with explosive force; when heated to decomposition, it emits highly toxic fumes of fluorides.
Toxicity: Can act as an asphyxiant and may have other toxic properties. See also Compressed Gases.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Nonflammable gas; green label.
Coast Guard Classification: Noninflammable gas; green gas label.

1, 2, 3, 6-TETRAHYDROBENZALDEHYDE
Description: Liquid.
Formula: $CH_2CHCH(CH_2)_2CHCHO$
Constants:
Mol. Wt. 110.15
M. P. -110°C
B. P. 164.5°C
Density 0.9733 @20°/20°C
Vap. Press. 1.6 mm @20°C
Vap. D. 3.80
Toxicity: See Aldehydes.
Disaster Control: Slightly dangerous; when heated, it emits acrid fumes.
Storage and Handling: Section 7

TETRAHYDRODIMETHYLFURANE
Description: Liquid.
Formula: $C_6H_{12}O$
Constant: Mol. Wt. 100.2
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

TETRAHYDROFURAN
Synonym: Cyclotetramethylene oxide.
Description: Colorless, mobile liquid; ether-like odor.
Formula: $OCH_2CH_2CH_2CH_2$
Constants:
Mol. Wt. 72.10 B. P. 65.4°C
Flash P. 1°F (T. C. C.)
Freezing P. -108.5°C
Density 0.888 @20°/4°C
Vap. Press. 114 mm @15°C
Vap. D. 2.5
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
MAC: ACGIH (tentative); 75 parts per million in air; 220 milligrams per cubic meter of air.
Fire Hazard: Dangerous (Section 6).
To Fight Fire: Foam, dry chemical,

carbon dioxide, or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, by chemical reaction.
Explosive Range: 2.3 - 11.8%. In common with other ethers, unstabilized tetrahydrofuran forms thermally explosive peroxides on exposure to air. It must always be tested for peroxides prior to distillation. Peroxides can be removed by treatment with strong ferrous sulfate solution made slightly acidic with sodium bisulfate.
Disaster Control: Dangerous; when heated, it emits toxic fumes; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

TETRAHYDROFURFURYL ALCOHOL

Description: A liquid.
Formula: $C_4H_7OCH_2OH$
Constants:
Mol. Wt. 102.13
M. P. < -80 °C
B. P. 178 °C @743 mm
Flash P. 167 °F (O. C.)
Density 1.0495 @20 °/4 °C
Autoign. Temp. 640 °F
Vap. D. 3.5
Toxicity: Details unknown. See Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, in the form of vapor when exposed to flame.
Explosive Range: 1.5 - 9.7% (between 72.5 - 122 °C)
Storage and Handling: Section 7

TETRAHYDROFURFURYL OLEATE

Description: A liquid.
Formula: $C_{23}H_{42}O_3$
Constants:
Mol. Wt. 366.6
B. P. 240 °C @5 mm
Flash P. 392 °F
Density 0.93
Vap. D. 12.65
Toxicity: Details unknown. See Alcohols and Oleic Acid.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

1,2,5,6-TETRAHYDRO-o-METHYLBENZOIC ACID

Description: Crystals.
Formula: $C_8H_{13}O_2$
Constant:
Mol. Wt. 141.2
Toxicity: Details unknown; a mite repellent.
Disaster Control: Slightly dangerous; when heated, it emits acrid fumes.
Storage and Handling: Section 7

TETRAHYDRONAPHTHALENE

Description: Colorless liquid.
Formula: $C_{10}H_{12}$
Constants:
Mol. Wt. 132.20
M. P. -30 °C
B. P. 207.2 °C
Flash P. 171 °F (C. C.)
Density 0.981
Vap. Press. 1 mm @38.0 °C
Vap. D. 4.55
Toxicity: Details unknown. See Naphthalene.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TETRAHYDRONAPHTHOL

Synonym: α-Naphthol-1,2,3,4-tetrahydride.
Description: Colorless liquid.
Formula: $C_6H_4C_4H_7OH$
Constants:
Mol. Wt. 148.2
B. P. 140 °C @17 mm
Density 1.090
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react

with oxidizing materials (Section 6).
Storage and Handling: Section 7

TETRAHYDROPHTHALIC ANHYDRIDE

Description: White powder.
Formula: $C_8H_8O_3$
Constants:
  Mol. Wt. 152.14
  M. P. 101.9°C
  B. P. 195°C @50 mm
  Flash P. 315°F (O.C.)
  Density 1.375 @25°/20°C
  Vap. Press. < 0.01 mm @20°C
  Vap. D. 5.25
Toxicity: Unknown.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Slightly dangerous; when heated, it emits acrid fumes; will react with water or steam to produce heat; can react with oxidizing materials.
Storage and Handling: Section 7

TETRAHYDROPYRAN

Synonyms: Pentamethylene oxide.
Description: Colorless, mobile liquid, ether-like odor.
Formula: $(CH_2)_5O$
Constants:
  Mol. Wt. 86.13
  B. P. 88°C
  Flash P. -4°F
  Density 0.8814 @20°/4°C
Toxic Hazard Rating:
  Acute Local: Irritant 2; Ingestion 2; Inhalation 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Moderate, by chemical reaction. It can form explosive peroxides if stored in uninhibited condition.
Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

TETRAHYDROPYRAN-2-METHANOL

Description: Liquid.
Formula: $\underbrace{OCH_2CH_2CH_2CH_2CH}CH_2OH$
Constants:
  Mol. Wt. 116.16
  Freezing P. -70°C
  B. P. 187°C
  Density 1.0272 @20°/20°C
  Vap. Press. 0.4 mm @20°C
  Vap. D. 4.02
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

TETRA ISOPROPYL TITANATE

Description: Colorless liquid.
Formula: $(C_3H_7O)_4Ti$
Constants:
  Mol. Wt. 284
  M. P. 20°C
  B. P. 232°C
  Density 0.955 @25°C
  Vap. D. 9.8
Toxicity: Details unknown. See also Esters.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

2,2,5,5-TETRAMETHYLAL CYCLOPENTANONE TETRANITRATE. See Nitrates.

TETRAMETHYL ETHYLENEDIAMINE

Formula: $(CH_3)_2NH_2CCNH_2(CH_2)_2$
Constant:
  Mol. Wt. 116.2
Toxicity: Details unknown. See also Amines.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

TETRAMETHYLSUCCINONITRILE

Synonym: TSN
Description: Crystallizes in plates; almost no odor.
Formula: $C_8H_{12}N_2$

Constants:
  Mol. Wt. 136.0
  M. P. 169°C (sublimes)
Toxicity: In the preparation of sponge rubber, an azo compound is used, which decomposes to form tetramethylsuccinonitrile or TSN. Animal experiments indicate that it is toxic. Rats exposed to a concentration of 90 ppm exhibit their first convulsion after 1.5 to 2 hours and were dead in 3 hours or less. Rats exposed to concentrations of 5.5 ppm exhibited their first convulsion in 27 to 31 hours and were dead in from 31 to 46 hours.
Treatment and Antidotes: It has been pointed out that this nitrile is different from other nitriles in that thiosulfate proved to be a poor antidote for intoxication. Barbiturates proved adequate for the control of convulsions. However, the barbiturates which have a short or medium period of action will relieve the condition only for a time. Afterwards, the symptoms may reappear, and eventually the death of the animal may ensue. This indicates that TSN is slowly detoxified by the body. The fatal dose is thought to be about 25 mg/kg of body weight. See also Cyanides.
Disaster Control: Dangerous. See Cyanides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

TETRAMETHYLTHIURAM DISULFIDE. See Bis(dimethyl thiocarbamyl) disulfide.

TETRAMETHYLTHIURAM MONOSULFIDE

Synonyms: Bis-dimethylthiocarbamyl sulfide.
Description: Yellow powder.
Formula: $[(CH_3)_2NCS]_2S$
Constant:
  Mol. Wt. 208.39
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: Ingestion 2; Inhalation 2
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

TETRAMMINE CADMIUM PERRHENATE

Description: Crystals.
Formula: $[Cd(NH_3)_4](ReO_4)_2$
Constants:
  Mol. Wt. 681.16
  Density 3.714 @25°/4°C
Toxicity: Details unknown. See also Cadmium Compounds.
Fire Hazard: Slight, by chemical reaction with reducing agents (Section 6).
Storage and Handling: Section 7

TETRAMMINECOPPER II SULFATE

Description: Rhombic, blue crystals.
Formula: $[Cu(NH_3)_4]SO_4 \cdot H_2O$
Constants:
  Mol. Wt. 245.75
  M. P. Decomposes @150°C
  Density 1.81
Toxicity: See Copper Compounds.

TETRAMMINE PLATINUM (II) CHLORIDE

Description: Tetragonal, colorless crystals.
Formula: $[Pt(NH_3)_4]Cl_2 \cdot H_2O$
Constants:
  Mol. Wt. 352.29
  M. P. 250°C; $-H_2O$ @100°C
  Density 2.737
Toxicity: See Platinum Compounds.

TETRAMMINE PLATINUM (II) CHLOROPLATINATE

Synonym: Mangus' salt.
Description: Green or red crystals.
Formula: $[Pt(NH_3)_4]PtCl_4$
Constants:
  Mol. Wt. 600.42
  M. P. Decomposes
  Density < 4.1
Toxicity: See Platinum Compounds.

TETRANAPHTHENE

Description: Crystals.
Formula: $C_6H_3C_4H_7C_2H_4$
Constant:
  Mol. Wt. 158.2
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1; Inhalation 1
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

TETRANAPHTHENOYL TRIETHYLENE TETRAMINE

Description: Liquid.
Constants:
  Flash P. 325°F
  Density 1.01
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TETRANITROANILINE

Synonym: TNA
Description: Solid.
Formula: $C_6H_3N_5O_8$
Constants:
  Mol. Wt. 273.12
  M. P. 170°C
  B. P. Explodes @237°C
Toxicity: Highly toxic. See Aniline.
Fire Hazard: See Nitrates.
Explosion Hazard: Severe, when shocked or exposed to heat. Tetranitroaniline is a powerful and sensitive high explosive, similar to tetryl. It deteriorates in the presence of moisture. It is used as a booster for high explosive shells and in primer and detonating compositions. See also Explosives, High and Nitrates.
Disaster Control: Dangerous; shock or heat will explode it; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react vigorously with reducing materials.
Storage and Handling: Section 7

TETRANITROCARBAZOLE

Description: Crystals.
Formula: $(NO_2)_4(C_6H_2)_2NH$
Constant:
  Mol. Wt. 347.6
Toxicity: Details unknown; probably toxic; an insecticide.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates and Explosives, High.
Disaster Control: Dangerous; shock will explode it; when heated to decomposition, it emits highly toxic fumes; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

TETRANITRODIGLYCERIN

Toxicity: See Nitroglycerin.
Fire Hazard: See Nitrates.
Explosion Hazard: Severe; when shocked or exposed to heat. Tetranitrodiglycerin resembles nitroglycerin, but is less sensitive. It is a component of low-freezing dynamites due to its own low-freezing point.
Disaster Control: Dangerous; shock will explode it; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

TETRANITROMETHANE

Description: Colorless liquid.
Formula: $C(NO_2)_4$
Constants:
  Mol. Wt. 196.04
  M. P. 13°C
  B. P. 125.7°C
  Density 1.650 @13°C
  Vap. Press. 10 mm @22.7°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
  Chronic Local: U
  Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
MAC: ACGIH (tentative); 1 part per million in air.
Toxicology: This material irritates

the eyes and respiratory passages and does serious damage to the liver. It occurs as an impurity in crude TNT, and is thought to be mainly responsible for the irritating properties of that material. It can cause pulmonary edema, mild methemoglobinemea, and fatty degeneration of the liver and kidneys. From animal experiments it has been found that concentrations as low as 0.1 ppm have proved rapidly fatal, and that concentrations of 3.3 to 25.2 ppm produced very rapid and marked irritation of mucous membranes of the eyes, mouth, and upper respiratory tract.

Fire Hazard: Dangerous. See Nitrates and Explosives, High.

Explosion Hazard: Severe, when shocked or exposed to heat. It can form very powerful explosives when mixed with other nitro high explosives which are somewhat oxygen-deficient. Its primary use is in blasting explosives and in detonating compositions.

Disaster Control: Highly dangerous; shock will explode it; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react vigorously with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

Shipping Regulations: Section 11.
Coast Guard Classification: Oxidizing material; yellow label.

TETRANITRONAPHTHALENE

Description: Crystals.

Formula: $C_{10}H_4(NO_2)_4$

Constants: M. P. 200°C (approx.)
Mol. Wt. 308.2 B. P. Explodes

Toxicity: Unknown.

Fire Hazard: Dangerous. See Nitrates.

Explosion Hazard: Severe, when shocked or exposed to heat. Tetranitronaphthalene is a much used high explosive equal to but somewhat less sensitive to impact than TNT. It is used for bursting charges. See also Nitrates and Explosives, High.

Disaster Control: Dangerous; shock or heat will explode it; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen; can react vigorously with reducing materials.

Storage and Handling: Section 7

TETRAPHENYL ARSONIUM BROMIDE

Description: Crystals.

Formula: $(C_6H_5)_4AsBr \cdot 2H_2O$

Constants:
Mol. Wt. 499.3
M. P. 282°C

Toxicity: Highly toxic. See Arsenic Compounds.

Disaster Control: Dangerous. See Arsenic Compounds.

Storage and Handling: Section 7

TETRAPHENYL ARSONIUM CHLORIDE

Description: Crystals.

Formula: $(C_6H_5)_4AsCl \cdot 2H_2O$

Constants:
Mol. Wt. 454.8
M. P. 259°C

Toxicity: Highly toxic. See Arsenic Compounds.

Disaster Control: Dangerous. See Arsenic Compounds.

Storage and Handling: Section 7

TETRAPHOSPHORUS HEPTASULFIDE

Description: Light yellow crystals.

Formula: P_4S_7

Constants:
Mol. Wt. 348.39
M. P. 310°C
B. P. 523°C
Density 2.19 @17°C

Toxicity: See Sulfides.

Fire Hazard: Moderate, when exposed to heat or flame or by chemical reaction. See also Sulfides.

Explosion Hazard: Moderate. See Sulfides.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur and phosphorus; will react with water, steam or acids to produce toxic and flammable vapors; can react with oxidizing

materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

TETRAPHOSPHORUS TRISELENIDE

Description: Orange-red crystals.
Formula: P_4Se_3
Constants:
Mol. Wt. 360.80
M. P. 242°C
B. P. 360 - 400°C
Density 1.31
For other properties, see Selenium Compounds and Phosphorus.

TETRAPHOSPHORUS TRISULFIDE

Description: Yellow crystals.
Formula: P_4S_3
Constants:
Mol. Wt. 220.12
M. P. 172.5°C
B. P. 407.5°C
Density 2.03
Toxicity: See Sulfides.
Fire Hazard: Dangerous, when exposed to heat, flame, or friction.
To Fight Fire: Water (Section 6).
Explosion Hazard: Moderate. See Sulfides.
Disaster Control: Dangerous; when heated to decompositon, it emits highly toxic fumes of oxides of phosphorus and sulfur; will react with water, steam or acids to produce toxic and flammable vapors; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

TETRAPYRIDINECADMIUM FLUOSILICATE

Description: White crystals.
Formula: $[(Cd(C_5H_5N)_4]SiF_6$
Constants:
Mol. Wt. 570.86
Density 2.282
For other properties, see Cadmium Compounds and Fluosilicates.

TETRAPYRIDINECOPPER II FLUOSILICATE

Description: Rhombic, purplish-blue crystals.
Formula: $[Cu(C_5H_5N)_4]SiF_6$
Constants:
Mol. Wt. 521.99
Density 2.108
Toxicity: See Fluosilicates and Copper Compounds.
Disaster Control: See Fluosilicates.

TETRAPYRIDINENICKEL (II) FLUOSILICATE

Description: Rhombic, blue-green crystals.
Formula: $[Ni(C_5H_5N)_4]SiF_6$
Constants:
Mol. Wt. 517.14
Density 2.307
Toxicity: See Silicofluorides and Nickel Compounds.
Disaster Control: See Fluosilicates.

TETRASILANE

Description: Colorless liquid.
Formula: Si_4H_{10}
Constants:
Mol. Wt. 122.32
M. P. −93.5°C
B. P. 109°C
Density 0.825 @0°C
Toxicity: Details unknown. See also Silanes.
Fire Hazard: Severe. Details unknown.
Explosion Hazard: Severe, by chemical reaction with oxygen; can detonate in air.
Disaster Control: Dangerous; on decomposition, it emits toxic fumes; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

TETRASODIUM PYROPHOSPHATE

Synonym: TSPP
Description: White powder.
Formula: $Na_4P_2O_7$
Constants:
Mol. Wt. 266
M. P. 880°C
Density 2.534
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U

Chronic Systemic: Ingestion 1; Inhalation 1
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

TETRAZENE

Synonym: Guanylnitrosaminoguanyl tetrazene.
Description: Solid.
Toxicity: Unknown
For other properties, see Nitrates.

TETRYL

Synonyms: Tetralite; trinitrophenylmethylnitramine.
Description: Yellow, monoclinic crystals.
Formula: $(NO_2)_3C_6H_2N(NO_2)CH_3$
Constants:
  Mol. Wt. 287.15
  M. P. 130°C
  B. P. Explodes @187°C
  Density 1.57 @19°C
Toxic Hazard Rating:
  Acute Local: Irritant 2
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: Irritant 2
  Chronic Systemic: Ingestion 2; Inhalation 2
MAC: ACGIH (accepted); 1.5 milligrams per cubic meter of air.
Toxicology: The chief effect produced by exposure to tetryl is the development of dermatitis. Conjunctivitis may be caused by rubbing the eyes with contaminated hands or through exposure to air-borne dust. Iridocyclitis and keratitis have developed as a sequel to the conjunctivitis. Some authorities consider that tetryl may be a cause of tracheitis and asthma. Sensitization which frequently occurs as a result of exposure to tetryl may play a part in all these conditions. Tetryl workers may develop a gastrointestinal symptoms, though these complaints are more common among T.N.T. workers. Anemia has been reported to occur frequently.
Fire Hazard: Dangerous. See Nitrates.
Explosion Hazard: Severe, when shocked or exposed to heat or flame. It is a powerful explosive quite sensitive to percussion and more sensitive to shock and friction than TNT. It can be compressed into pellets for use as a booster explosive. It is used in reinforced detonators and is considered to be the standard booster charge for high explosive shells.
Disaster Control: Dangerous. See Nitrates.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: See Explosives, High.

TEXTILE WASTE, WET

Fire Hazard: Moderate, when exposed to heat or by chemical reaction with oxidizing agents (Section 6).
Spontaneous Heating: Moderate.
Ventilation Control (use normal rate): Section 2
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid; yellow label.

THALLIC NITRATE

Description: Crystals.
Formula: $Tl(NO_3)_3$
Constant:
  Mol. Wt. 390.41
Toxicity: See Thallium Compounds and Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of nitrogen and thallium.
Storage and Handling: Section 7

THALLIC OXIDE

Description: Hexagonal, black crystals; amorphous prisms.
Formula: Tl_2O_3
Constants:
  Mol. Wt. 456.78
  M. P. 717° ± 5°C
  B. P. –20 @875°C
  Density amorphous: 9.65 @21°C; hexagonal: 10.19 @22°C

Toxicity: See Thallium Compounds.
Fire Hazard: Slight, by chemical reaction. Evolves oxygen @875°C (Section 6).
Disaster Control: See Thallium Compounds.
Storage and Handling: Section 7

THALLIC SULFIDE
Description: Black, amorphous powder.
Formula: Tl_2S_3
Constant: Mol. Wt. 504.98
For other properties, see Sulfides and Thallium Compounds.

THALLIUM
Description: Bluish-white, soft and malleable metal.
Formula: Tl
Constants:
At. Wt. 204.39
M. P. 302°C
B. P. 1457 ± 10°C
Density 11.85
Vap. Press. 1 mm @825°C
Toxicity: See Thallium Compounds.
Radiation Hazard (Section 5): Artificial isotope Tl^{204}, half-life: 2.7 years; emits beta particles of 0.78 mev. Natural isotope Tl^{208} (Thorium C^{11}), half-life: 3.1 minutes; emits beta particles of 1.79 mev and many gamma rays between 0.23 - 2.6 mev. Tl^{208} is a member of the thorium series. Since its half-life is very short, Tl^{208} is only of interest from its position in the series as a daughter of thoron.
Fire Hazard: Moderate, in the form of dust, when exposed to heat or flame. See also Powdered Metals (Section 6).
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Thallium Salts, solid: Poison B; poison label.
Coast Guard Classification: Thallium Salts, solid: Poison B; poison label.

THALLIUM ACETATE
Synonym: Thallous acetate.
Description: Silk-white crystals.
Formula: $TlC_2H_3O_2$
Constants:
Mol. Wt. 263.43
M. P. 110°C
Density 3.68
For other properties, see Thallium Compounds.

THALLIUM AZIDE
Description: Yellow crystals.
Formula: TlN_3
Constants:
Mol. Wt. 246.41
M. P. 334°C
Toxicity: Highly toxic. See Azides and Thallium Compounds.
Explosion Hazard: Unknown
Disaster Control: Dangerous. See Thallium Compounds.

THALLIUM BROMATE
Description: Colorless crystals.
Formula: $TlBrO_3$
Constant:
Mol. Wt. 332.31
Toxicity: Highly toxic. See Thallium Compounds and Bromates.
Fire Hazard: Moderate. See Bromates.
Disaster Control: Dangerous. See Thallium Compounds and Bromates.
Storage and Handling: Section 7

THALLIUM BROMIDE
Synonym: Thallous bromide.
Description: Yellowish-white powder.
Formula: TlBr
Constants:
Mol. Wt. 284.31
M. P. 460°C (approx.)
B. P. 815°C
Density 7.557
Vap. Press. 10 mm @522°C
Toxicity: Highly toxic. See Thallium Compounds and Bromides.
Disaster Control: Dangerous. See Thallium Compounds and Bromides.
Storage and Handling: Section 7

THALLIUM CARBONATE
Description: Monoclinic, colorless crystals.
Formula: Tl_2CO_3
Constants:
Mol. Wt. 468.79
M. P. 273°C
Density 7.11

For other properties, see Thallium Compounds.

THALLIUM CHLORATE

Synonym: Thallous chlorate.
Description: Solid.
Formula: $TlClO_3$
Constants:
Mol. Wt. 287.85
Density 5.047 @90°C
For other properties, see Chlorates and Thallium Compounds.

THALLIUM CHLORIDE

Synonym: Thallous chloride.
Description: Colorless or white powder.
Formula: $TlCl$
Constants:
Mol. Wt. 239.85
M. P. 430°C
B. P. 720°C
Density 7.00
Vap. Press. 10 mm @517°C
For other properties, see Thallium Compounds.

THALLIUM CHLOROPLATINATE

Description: Pale orange crystals.
Formula: Tl_2PtCl_6
Constants:
Mol. Wt. 816.75
Density 5.76 @17°C
For other properties, see Thallium Compounds.

THALLIUM CHROMATE

Description: Yellow crystals.
Formula: Tl_2CrO_4
Constant:
Mol. Wt. 524.8
For other properties, see Chromium Compounds and Thallium Compounds.

THALLIUM COMPOUNDS

Toxic Hazard Rating:
Acute Local: Ingestion 2
Acute Systemic: Ingestion 3; Inhalation 2
Chronic Systemic: Ingestion 3; Inhalation 2

Toxicology: Acute poisoning usually follows the ingestion of toxic quantities of a thallium-bearing depilatory, or accidental or suicidal ingestion of rat poison. Children have been known to tolerate 8 mgm of thallium acetate per kilogram of weight, but adults and adolescents have not. Acute poisoning results in swelling of the feet and legs, arthralgia, vomiting, insomnia, hyperesthesia and paresthesia of the hands and feet, mental confusion, polyneuritis with severe pains in the legs and loins, partial paralysis of the legs with reaction of degeneration, angina-like pains, nephritis, wasting and weakness, and lymphocytosis and eosinophilia. About the 18th day, complete loss of the hair of the body and head occurs. Fatal poisoning has been known to occur.

Industrial poisoning is reported to have caused discoloration of the hair, which later falls out, joint pains, loss of appetite fatigue, severe pain in the calves of the legs, albuminuria, eosinophilia and lymphocytosis, and optic neuritis followed by atrophy. Cases of industrial poisoning are rare, however.

Disaster Control: Dangerous; when heated, they emit highly toxic fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

THALLIUM CYANIDE

Synonym: Thallous cyanide.
Description: Tablets.
Formula: $TlCn$
Constants: Mol. Wt. 230.41
M. P. Decomposes
For other properties, see Cyanides.

THALLIUM DICHROMATE

Synonym: Thallous dichromate.
Description: Red crystals.
Formula: $Tl_2Cr_2O_7$
Constant:
Mol. Wt. 624.80
For other properties, see Chromium Compounds and Thallium Compounds.

THALLIUM DITHIONATE

Synonym: Thallous dithionate.
Description: Monoclinic crystals.
Formula: $Tl_2S_2O_6$

Constants:
Mol. Wt. 568.91
M. P. Decomposes
Density 5.57
For other properties, see Thallium Compounds.

THALLIUM ETHOXIDE
Description: Colorless liquid.
Formula: $[TlOC_2H_5]_4$
Constants:
Mol. Wt. 997.80
M. P. −3 °C
B. P. Decomposes @ 80 °C
Density 3.522
Toxicity: Highly toxic. See Thallium Compounds.
Fire Hazard: Moderate, when exposed to heat or flame.
Disaster Control: Dangerous; when heated it emits highly toxic fumes; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

THALLIUM FERROCYANIDE
Description: Triclinic, yellow crystals.
Formula: $Tl_4Fe(CN)_6 \cdot 2H_2O$
Constant:
Mol. Wt. 1065.55
Density 4.641
For other properties, see Thallium Compounds and Ferrocyanides.

THALLIUM FLUOGALLATE
Description: Colorless crystals.
Formula: $Tl_2(GaF_5H_2O)$
Constants:
Mol. Wt. 591.52
Density 6.44
For other properties, see Fluogallates and Thallium Compounds.

THALLIUM FLUOSILICATE
Description: Hexagonal plates.
Formula: $Tl_2SiF_6 \cdot 2H_2O$
Constant:
Mol. Wt. 586.87
For other properties, see Fluosilicates and Thallium Compounds.
Disaster Control: See Fluosilicates and Thallium Compounds.
Storage and Handling: Section 7

THALLIUM HYDROXIDE
Synonym: Thallous hydroxide.
Description: Pale yellow needles.
Formula: TlOH
Constants:
Mol. Wt. 221.40
B. P. Decomposes @ 139 °C
For other properties, see Thallium Compounds.

THALLIUM IODIDE
Synonym: Thallium monoiodide.
Description: Cubic red crystals; yellow powder.
Formula: TlI
Constants:
Mol. Wt. 331.31
M. P. 440 °C
B. P. 824 °C
Density 7.09
Vap. Press. 1 mm @ 440 °C
For other properties, see Thallium Compounds and Iodides.

THALLIUM MONOFLUORIDE
Synonym: Thallous fluoride.
Description: Cubic, colorless crystals.
Formula: TlF
Constants:
Mol. Wt. 223.39
B. P. 300 °C
For other properties, see Thallium Compounds and Fluorides.

THALLIUM MONOXIDE
Synonyms: Thallium oxide; thallous oxide.
Description: Black, deliquescent crystals.
Formula: Tl_2O
Constants:
Mol. Wt. 424.78
M. P. 300 °C
B. P. 1080 °C @ 600 mm; $-O_2$ @ 1865 °C
For other properties, see Thallium Compounds.

THALLIUM NITRATE
Synonym: Thallous nitrate.
Description: Cubic crystals..
Formula: $TlNO_3$
Constants:
Mol. Wt. 266.40
M. P. 206 °C
B. P. 430 °C
For other properties, see Thallium Compounds and Nitrates.

THALLIUM OLEATE
Synonym: Thallous oleate.
Description: White, crystalline clusters.
Formula: $TlC_{18}H_{33}O_2$
Constants:
Mol. Wt. 485.83
M. P. 131 -2°C
For other properties, see Thallium Compounds.

THALLIUM OXALATE
Synonym: Thallous oxalate.
Description: Monoclinic prisms.
Formula: $Tl_2C_2O_4$
Constants:
Mol. Wt. 496.80
Density 6.31
Toxicity: Highly toxic. See Oxalates and Thallium Compounds.
Disaster Control: See Thallium Compounds.

THALLIUM PERCHLORATE
Synonym: Thallous perchlorate.
Description: Colorless crystals.
Formula: $TlClO_4$
Constants:
Mol. Wt. 303.85
M. P. 501°C
B. P. Decomposes
Density 4.89
For other properties, see Thallium Compounds and Perchlorates.

THALLIUM PEROXIDE. See Thallic Oxide.

THALLIUM PHENOXIDE
Synonym: Thallous phenoxide.
Description: White crystals.
Formula: $TlOC_6H_5$
Constants:
Mol. Wt. 297.49
M. P. 233°C
Toxicity: See Thallium Compounds and Phenol.
Disaster Control: See Thallium Compounds.

THALLIUM o-PHOSPHATE
Synonym: Thallous o-phosphate
Description: Colorless needles.
Formula: Tl_3PO_4
Constants: Mol. Wt. 708.15
Density 6.89
Toxicity: Highly toxic. See Thallium Compounds.
Disaster Control: See Thallium Compounds and Phosphates.

THALLIUM PICRATE
Description: Red or yellow crystals.
Formula: $TlC_6H_2N_3O_7$
Constants: Mol. Wt. 432.49
M. P. Explodes @273 - 275°C
Density Red: 3.164 @17°C;
Yellow: 2.993 @17°C
Toxicity: Highly toxic. See Thallium Compounds and Picrates.
Fire Hazard: Dangerous. See Nitrates.
Explosion Hazard: Explodes at 275°C.
Disaster Control: Dangerous. See Thallium Compounds and Nitrates.
Storage and Handling: Section 7

THALLIUM PYROVANADATE
Description: Solid.
Formula: $Tl_4V_2O_7$
Constants:
Mol. Wt. 1031.46
M. P. 454°C
Density 8.21 @19°C
Toxicity: Highly toxic. See Thallium Compounds.
Disaster Control: See Thallium Compounds.
Storage and Handling: Section 7

THALLIUM SELENATE
Synonym: Thallous selenate.
Description: Rhombic needles.
Formula: Tl_2SeO_4
Constants:
Mol. Wt. 551.74
M. P. > 400°C
Density 6.875
Toxicity: Highly toxic. See Selenium Compounds and Thallium Compounds.
Disaster Control: See Thallium Compounds and Selenium Compounds.

THALLIUM SELENIDE
Synonym: Thallous selenide.
Description: Gray leaf.
Formula: Tl_2Se
Constants:
Mol. Wt. 487.74
M. P. 340°C
Toxicity: Highly toxic. See Selenium Compounds and Thallium Compounds.
Fire Hazard: Moderate, by chemical reaction. See also Hydrogen Selenide (Section 6).
Explosion Hazard: Slight, by chemical reaction. See also Hydrogen Selenide.

Disaster Control: Dangerous. See Thallium Compounds and Selenium Compounds.
Storage and Handling: Section 7

THALLIUM SESQUICHLORIDE

Description: Hexagonal yellow crystals or yellow powder.
Formula: Tl_2Cl_3
Constants:
Mol. Wt. 515.15
M. P. 400° – 500°C
B. P. Decomposes
Density 5.9
Toxicity: Highly toxic. See Thallium Compounds.
Disaster Control: See Thallium Compounds and Chlorides.

THALLIUM SILVER NITRATE

Synonym: Thallous silver nitrate.
Description: White crystalline powder.
Formula: $TlNO_3 \cdot AgNO_3$
Constants:
Mol. Wt. 436.29
M. P. 75°C
Toxicity: Highly toxic. See Thallium Compounds.
Fire Hazard: See Nitrates.
Disaster Control: Dangerous. See Nitrates.
Storage and Handling: Section 7

THALLIUM STEARATE

Synonym: Thallous stearate.
Description: Needles.
Formula: $TlC_{18}H_{35}O_2$
Constants:
Mol. Wt. 487.85
M. P. 119°C
For other properties, see Thallium Compounds.

THALLIUM SULFATE

Synonym: Thallous sulfate.
Description: Colorless crystals.
Formula: Tl_2SO_4
Constants: Mol. Wt. 504.84
M. P. 632°C
B. P. Decomposes
Density 6.77
For other properties, see Thallium Compounds.
Shipping Regulations: Section 11
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.
MCA warning label.

THALLIUM SULFIDE

Synonyms: Thallium monosulfide; thallous sulfide.
Description: Blue-black powder.
Formula: Tl_2S
Constants:
Mol. Wt. 440.84
M. P. 443°C
B. P. Decomposes
Density 8.0
For other properties, see Thallium Compounds and Sulfides.

THALLIUM SULFITE

Synonym: Thallous sulfite.
Description: Crystals.
Formula: Tl_2SO_3
Constants:
Mol. Wt. 488.85
Density 6.427
For other properties, see Thallium Compounds and Sulfites.

THALLIUM m-TELLURATE

Synonym: Thallous m-tellurate.
Description: Heavy white precipitate.
Formula: Tl_2TeO_4
Constants:
Mol. Wt. 600.39
M. P. Red heat
Density 6.760 @17.6°C
For other properties, see Thallium Compounds and Tellurium Compounds.

THALLIUM THIOCYANATE

Synonym: Thallous thiocyanate.
Description: Tetragonal, colorless crystals.
Formula: TlSCN
Constant:
Mol. Wt. 262.47
For other properties, see Thallium Compounds.

THALLIUM TRIIODIDE

Description: Brown needles.
Formula: TlI_3
Constant:
Mol. Wt. 585.15
For other properties, see Thallium Compounds.

THALLOUS HYDROGEN SULFATE

Synonym: Thallium hydrogen sulfate.
Description: Crystals.
Formula: $TlHSO_4$
Constants: Mol. Wt. 301.46
M. P. 120°C decomposes

For other properties, see Thallium Compounds and Sulfuric Acid.

THEBAINE

Synonym: Paramorphine.
Description: White to slightly yellowish, lustrous leaflets or prisms.
Formula: $C_{19}H_{21}NO_3$
Constants:
  Mol. Wt. 311.37
  M. P. 193°C
  Density 1.305
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

THEOBROMINE

Synonym: 3,6-Dimethylxanthine.
Description: White powder; bitter taste.
Formula: $C_7H_8N_4O_2$
Constants:
  Mol. Wt. 180.17
  M. P. 337°C
    Sublimes @260°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 1; Inhalation 1
  Chronic Local: U
  Chronic Systemic: Ingestion 1; Inhalation 1
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

THEOBROMINE SODIUM ACETATE.

See Theobromine.

THEOBROMINE SODIUM SALICYLATE.

See Theobromine.

THEOBROMOSE

Synonym: Theobromine lithium.
Description: Needle-like crystals.
Formula: $C_7H_7O_2N_4Li$
Constant:
  Mol. Wt. 186.10
Toxicity: Details unknown. See also Theobromine and Lithium Compounds.
Disaster Control: Moderately dangerous; when heated to decomposition, it emits lithium oxide fumes.
Storage and Handling: Section 7

THEOPHORIN

Synonym: Theobromine-sodium formate.
Description: White powder.
Formula:
  $C_7H_7N_4O_2Na \cdot HCOONa \cdot H_2O$
Constant:
  Mol. Wt. 288.13
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated, it emits highly toxic fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

THEOPHYLLINE

Synonym: 1,3-Dimethylxanthine.
Description: Monoclinic, odorless needles; bitter taste.
Formula: $C_7H_8N_4O_2$
Constants:
  Mol. Wt. 180.17
  M. P. 269.72°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 1; Inhalation 1
  Chronic Local: U
  Chronic Systemic: Ingestion 1; Inhalation 1
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

"THERMIT"

Formula: $Fe_2O_3 + Al$

Toxicity: See Aluminum Compounds and Iron Compounds.

Fire Hazard: Dangerous, when exposed to heat or flame. The reaction of $Fe_2O_3 + Al$ is typical of a series of oxide-metal reactions. They are very dangerous in that once started they are very difficult to stop, as they supply their own oxygen. They may attain a temperature of about 2500°C (Section 6).

Disaster Control: Dangerous; keep away from combustible materials.

Storage and Handling: Section 7

THIALDINE

Synonym: 5, 6-Dihydro-2, 3, 6-trimethyl-1, 3, 5-dithiazine.

Description: Powder.

Formula:
$SCH(CH_3)SCH(CH_3)NHCHCH_3$

Constants:
Mol. Wt. 163.29
M. P. 44.4°C
B. P. Decomposes
Flash P. 200°F (O.C.)
Density 1.191
Vap. D. 5.63

Toxicity: Unknown

Fire Hazard: Moderate, when exposed to heat or flame.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes.

Storage and Handling: Section 7

THIENYL-α-PYRROLIDINE

Toxicity: Details unknown; an insecticide.

Disaster Control: Dangerous; when heated, it emits highly toxic fumes.

Storage and Handling: Section 7

THIOACETAMIDE

Description: Colorless leaflets.

Formula: CH_3CSNH_2

Constants:
Mol. Wt. 75.20
M. P. 109°C

Toxic Hazard Rating:
Acute Local: Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U

Disaster Control: Dangerous. See Sulfides.

Ventilation Control (use normal rate): Section 2

Personal Hygiene: Section 3

Storage and Handling: Section 7

THIOACETIC ACID

Synonyms: Ethanethiolic acid, methanecarbothiolic acid, thiacetic acid.

Description: Colorless liquid; pungent, disagreeable odor.

Formula: CH_3COSH

Constants:
Mol. Wt. 76.11
M. P. Below -17°C
B. P. 93°C
Density 1.074 @10°/4°C

Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U

For other properties, see Sulfides.

2, 2'-THIOBIS (4, 6-DICHLOROPHENOL). See Bithionol.

THIOCARBAMO SULFONAMIDES

Toxicity: Details unknown, but probably toxic. A fungicide.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.

Storage and Handling: Section 7

THIOCARBANILIDE

Synonyms: N, N'-diphenyl thiourea; 1, 3-diphenyl-2-thiourea.

Description: White to faint gray powder.

Formula: $C_6H_5NHC(S)NHC_6H_5$

Constants: Mol. Wt. 228.3
M. P. 154°C
B. P. Decomposes
Density 1.32 @25°C

Toxicity: Unknown

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.

Storage and Handling: Section 7

THIOCARBONYL CHLORIDE

Synonyms: Thiophosgene.
Description: Reddish, oily liquid; irritating odor.
Formula: $CSCl_2$
Constants:
  Mol. Wt. 115
  B. P. 74°C
  Density 1.5085
  Vap. D. 4
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Highly dangerous; when heated, it emits highly toxic fumes; on contact with acids, water or steam it evolves toxic and corrosive fumes.
Ventilation Control (use high rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  Coast Guard Classification: Poison B; poison label.

THIOCARBONYL TETRACHLORIDE

Description: Yellow crystals.
Formula: $CSCl_4$
Constants:
  Mol. Wt. 185.90
  B. P. 149°C (slight decomp.)
  Density 1.712 @13°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Highly dangerous; when heated, it emits highly toxic fumes of chlorides and oxides of sulfur; will react with water, steam or acids to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

THIOCYANATES

Toxicity: Variable. Thiocyanates are not normally dissociated into cyanide; they have a low acute toxicity. Prolonged absorption may produce various skin eruptions, running nose, and ocasionally dizziness, cramps, nausea, vomiting and mild or severe disturbances of the nervous system.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, they emit highly toxic fumes of cyanides.
Storage and Handling: Section 7

THIOCYANIC ACID

Synonym: Isocyanic acid.
Description: Colorless gas.
Formula: $HSCN$
Constants: Mol. Wt. 59.09
  M. P. 5°C
  B. P. Decomposes
Toxicity: Moderate. See Thiocyanates.
Disaster Control: See Thiocyanates.
Storage and Handling: Section 7

p-THIOCYANOCHLOROBENZENE

Description: Crystals.
Formula: ClC_6H_4SCN
Constant:
  Mol. Wt. 169.6
Toxicity: Details unknown; a fumigant. See Chlorobenzene.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides and chlorides.
Storage and Handling: Section 7

THIOCYANOGEN

Description: Liquid or yellow solid.
Formula: $(SCN)_2$
Constants:
  Mol. Wt. 116.17
  M. P. −2 to −3°C (decomp.)
Toxicity: Details unknown. Probably highly toxic.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur and cyanides.
Storage and Handling: Section 7

THIOCYANOPROPYL PHENYL ETHER

Toxicity: Details unknown; an insecticide.
Fire Hazard: Details unknown. See also Ethers.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.
Storage and Handling: Section 7

THIODIETHYLENE GLYCOL

Synonym: Thiodiglycol.
Description: Syrupy, colorless liquid; characteristic odor.
Formula: $(CH_2CH_2OH)_2S$
Constants:
Mol. Wt. 122.2
M. P. -11.2°C
B. P. 282°C
Flash P. 320°F (O.C.)
Density 1.1847 @20°/20°C
Vap. D. 4.21
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react with oxidizing materials.
Storage and Handling: Section 7

THIODIGLYCOLIC ACID

Description: A white powder.
Formula: $HOOCCH_2SCH_2COOH$
Constants:
Mol. Wt. 150
M. P. 128°C
Toxicity: Details unknown; probably moderately toxic.
Disaster Control: Moderately dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits toxic fumes.
Storage and Handling: Section 7

THIODIPHENYLAMINE. See Phenothiazine.

β,β'-THIODIPROPIONITRILE

Description: White crystals.
Formula: $S(CH_2CH_2CN)_2$
Constants:
Mol. Wt. 140.20
M. P. Alpha = 28.65°C; Beta = 22.10°C
Density 1.1095 @30°C
Toxicity: Highly toxic. See Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

THIOGLYCOLIC ACID

Synonyms: Mercaptoacetic acid; 2-mercaptoethanoic acid.
Description: Liquid.
Formula: $HSCH_2COOH$
Constants:
Mol. Wt. 92.11
M. P. -16.5°C
B. P. 104 - 106°C @11 mm
Density 1.3253 @20°/4°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 2
Chronic Local: Irritant 2
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 2
For other properties, see Hydrogen Sulfide, which is readily evolved by this compound.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

THIOMALIC ACID

Description: Off white powder.
Formula:
$HCO_2CH_2C(SH)HCO_2H$
Constants:
Mol. Wt. 150.2
M. P. 150°C
Toxicity: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits toxic fumes.
Storage and Handling: Section 7

THIONYL BROMIDE

Description: Yellow liquid.
Formula: $SOBr_2$
Constants:
Mol. Wt. 207.90
M. P. -52°C to -50°C
B. P. 138°C @773 mm
Density 2.68 @18°C
Vap. Press. 10 mm @31.0°C

Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Local: U
  Chronic Systemic: Inhalation 2
Disaster Control: Dangerous; when heated it emits highly toxic fumes; will react with water, steam or acids to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

THIONYL CHLORIDE

Synonym: Sulfurous oxychloride.
Description: Colorless to yellow to red liquid.
Formula: $SOCl_2$
Constants:
  Mol. Wt. 119.0
  M. P. -105°C
  B. P. 78.8 @746 mm
  Density 1.640 @15.5°/15.5°C
  Vap. Press. 100 mm @21.4°C
Toxicity: This material has a pungent odor similar to that of sulfur dioxide, and fumes upon exposure to air. In the presence of moisture it decomposes into hydrogen chloride and sulfur dioxide. Both these decomposition products are very toxic and constitute serious toxic hazards. The material itself is more toxic than sulfur dioxide. In experiments with animals, it was found that an exposure of 20 minutes to a concentration of 17.5 ppm was fatal to cats. It is classified as a corrosive liquid and can cause burns of the skin, eyes, and mucous membranes wherever it comes in contact with the body. See also Hydrogen Chloride and Sulfur Dioxide.
Treatment and Antidotes: Personnel exposed should follow the treatment outlined under hydrogen chloride and sulfur dioxide.
Disaster Control: Corrosive. See Hydrochloric Acid and Sulfur Dioxide.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Corrosive liquid; white label.
  Coast Guard Classification: Corrosive liquid; white label.
  MCA warning label.

THIONYL CHLORIDE FLUORIDE

Description: Gas.
Formula: SOClF
Constants:
  Mol. Wt. 102.52
  M. P. -139.5°C
  B. P. 12.2°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Inhalation 3
  Acute Systemic: Inhalation 3
  Chronic Local: Irritant 2; Inhalation 3
  Chronic Systemic: Inhalation 2
Disaster Control: Dangerous; shock can shatter the gas container, releasing the contents; when heated, it emits highly toxic fumes; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

THIONYL FLUORIDE

Description: Colorless gas.
Formula: SOF_2
Constants:
  Mol. Wt. 86.07
  B. P. -30°C
  Density 2.93
  M. P. -110°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Inhalation 3
  Acute Systemic: Inhalation 3
  Chronic Local: Inhalation 3
  Chronic Systemic: Inhalation 3
Disaster Control: Dangerous; shock can shatter the container, releasing the contents; when heated, it emits highly toxic fumes; will

react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

THIOPHENE
Synonym: Thiofuran.
Description: Clear and colorless liquid.
Formula: $\mathrm{\underline{SCHCHCHC}H}$
Constants:
Mol. Wt. 84.13
B. P. 84.1 °C
Freezing P. −38.3 °C
Flash P. > 30 °F
Density 1.0583 @25°/4 °C
Vap. Press. 40 mm @12.5 °C
Vap. D. 2.9
Toxicity: Details unknown. Considered to be more toxic than benzene.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

THIOPHOSGENE. See Thiocarbonyl Chloride.
Shipping Regulations: Section 11.
Coast Guard Classification: Poison B; poison label.

THIOPHOSPHORAMIDE
Description: Amorphous, yellow-white powder.
Formula: $PS(NH_2)_3$
Constants:
Mol. Wt. 111.12
M. P. Decomposes @200 °C
Density 1.7 @13 °C
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur and phosphorus.
Storage and Handling: Section 7

THIOPHOSPHORYL BROMIDE
Description: Cubic yellow crystals.
Formula: $PSBr_3$
Constants:
Mol. Wt. 302.8
M. P. 38 °C
B. P. Decomposes @175 °C
Density 2.85 @17 °C
Toxicity: Details unknown; probably toxic. See also Bromides.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of bromides, oxides of sulfur and phosphorus; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

THIOPHOSPHORYL CHLORIDE
Synonym: Phosphorus sulfochloride.
Description: Colorless, mobile liquid, pungent odor.
Formula: $PSCl_3$
Constants:
Mol. Wt. 169.45
B. P. 125 °C
Freezing P. −35 °C
Flash P. None
Density 1.63 @25°/4 °C
Vap. Press. 22 mm @25 °C
Vap. D. 5.86
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated it emits highly toxic fumes; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

THIOPHOSPHORYL DIBROMIDE CHLORIDE

Description: Pale green, fuming liquid.
Formula: $PSBr_2Cl$
Constants:
Mol. Wt. 258.34
M. P. −60°C
B. P. 98°C @60 mm
Density Liquid: 2.48 @0°C
Toxicity: Highly corrosive and toxic. See Thiophosphoryl Chloride.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

THIOPHOSPHORYL FLUORIDE

Description: Gas.
Formula: PSF_3
Constants:
Mol. Wt. 120.05
M. P. 3.8°C @7.6 atm.
B. P. Decomposes
Toxic Hazard Rating:
Acute Local: Irritant 3; Inhalation 3
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Inhalation 3
Chronic Systemic: Inhalation 2
MAC: ACGIH (accepted); 2.5 milligrams per cubic meter of air.
Disaster Control: Dangerous; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

"THIOSEMICARBAZONE"

Synonym: p-Acetylaminobenzaldehyde thiosemicarbazone.
Description: Pale yellow crystals.
Formula: $C_{10}H_{12}N_4OS$
Constants:
Mol. Wt. 236.3
M. P. 207°C
Toxicity: Details unknown; probably toxic; an insecticide.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

THIOSULFATES

Toxicity: Up to 12 grams of sodium thiosulfate can be taken daily by mouth with no ill effect except catharsis. Most of the thiosulfates have low toxicity.
Disaster Control: Dangerous; when heated to decomposition, they emit highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

THIOSULFURIC ACID

Formula: $H_2S_2O_3$
Constant:
Mol. Wt. 114.15
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; will react with water or steam to produce heat.
Storage and Handling: Section 7

THIOUREA

Synonym: Thiocarbamide.
Description: White powder or crystals.
Formula: NH_2CSNH_2
Constants: Mol. Wt. 76.1
M. P. 180 - 182°C
B. P. Decomposes
Density 1.405
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 1; Inhalation 1
Chronic Local: U
Chronic Systemic: Ingestion 1; Inhalation 1
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.
Personal Hygiene: Section 3
Storage and Handling: Section 7

THIOVANIC ACID. See Thioglycolic Acid.

THIOVANOL. See Mononthioglycerol.

1,4-THIOXANE

Description: Water, white, refractive mobile liquid; characteristic odor.

Formula: $O(CH_2CH_2)_2S$

Constants:

Mol. Wt. 104.1

B. P. 148.7°C

Freezing P. −17°C

Flash P. 108°F (C.C.)

Density 1.117 @20°C

Toxicity: Details unknown; probably moderately toxic.

Fire Hazard: Moderate, when exposed to heat or flame.

To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react with oxidizing materials.

Storage and Handling: Section 7

p-THIOXENE

Synonyms: 2,4-Thioxene; 2,4-dimethyl thiophene.

Description: Liquid.

Formula: $(CH_3)_2C_4H_2S$

Constants:

Mol. Wt. 112.2

B. P. 138°C

Density 0.9956 @20°C

Toxic Hazard Rating:

Acute Local: U

Acute Systemic: Inhalation 2; Skin Absorption 2

Chronic Local: U

Chronic Systemic: U

Fire Hazard: Moderate, when exposed to heat or flame.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react with oxidizing materials.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

THORIUM

Description: Cubic, gray crystals.

Formula: Th

Constants: At. Wt. 232.12

M. P. 1845°C

B. P. > 3000°C

Density 11.2

Radiation Hazard (Section 5): Natural isotope Th^{228} (Radiothorium), half-life: 1.9 years; emits alpha particles of 5.4 mev and gamma rays of 0.08 mev. Th^{228} is a member of the thorium series. The following members of the series come to equilibrium with Th^{228} very rapidly and may present either an internal or an external hazard. $Thorium^{228}$ is a source of thoron and the precautions given under thoron (Rn^{220}) should be followed.

Natural isotope Th^{232}, half-life: 1.39×10^{10} years; emits alpha particles of 3.98 mev. Th^{232} is the parent of the thorium series. While no permissible level is given in NBS Handbook No. 42, the activity level given for uranium might be considered a temporary working standard. While there are differences in metabolism and relative half-lives of members of the system, there are no data available for determining a better figure. Th^{232} is a source of thoron and precautions recommended under thoron (Rn^{220}) should be followed.

Natural isotope Th^{234} (UX_1), half-life: 24.1 days; emits beta particles of 0.11 mev (20%) and 0.205 mev (80%) and gamma rays of 0.093 mev. The permissible levels are: In body: 120 microcuries; in air: 6×10^{-7} microcurie per milliliter; in water: 3 microcuries per milliliter. Th^{234} is the direct daughter of U^{238} in the uranium series. Th^{234} and its daughter, Pa^{234}, are the source of β radiation from uranium which has been separated from radium and other daughters.

Fire Hazard: Moderate, in the form of dust, when exposed to heat or flame or by chemical reaction with oxidizers. See Powdered Metals (Section 6).

Ventilation Control (use moderate rate): Section 2

Personnel Hygiene: Section 3

Shipping Regulations: Section 11.

I.C.C. Classification: Flammable solid; yellow label.

Coast Guard Classification: Inflammable solid; yellow label.

THORIUM COMPOUNDS

For radiation hazard, see Thorium.

THORIUM PICRATE

Description: Crystalline powder.
Formula: $Th(C_6H_2N_3O_7)_4 \cdot 10H_2O$
Constant:
Mol. Wt. 1324.68
Toxicity: See Picrates.
Radiation Hazard: See Thorium
Fire Hazard: Dangerous. See Nitrates.
Explosion Hazard: Severe. See Nitrates.
Disaster Control: Highly dangerous; See Nitrates.
Storage and Handling: Section 7

THORON

Description: An inert gas.
Formula: Tn or Rn^{220}
Constant:
At. Wt. 220
Toxicity: See Radiation Hazard under Thorium.
Radiation Hazard (Section 5): Natural isotope Rn^{220} (Thoron), half-life: 54.5 seconds; emits alpha particles of 6.28 mev. Rn^{220} is a member of the thorium series. No permissible level is given in NBS Handbook No. 42, but a level of 10^{-2} microcurie per milliliter has been recommended.

While thoron is very short-lived, it is formed rapidly from all thorium compounds. It and its daughters may present an inhalation hazard. Good ventilation of all areas where thorium or its daughters are handled or stored is recommed.
Ventilation Control (use moderate rate): Section 2

THULIUM

Description: A rare earth metallic element.
Formula: Tm
Constant:
At . Wt. 169.40
Toxicity: Unknown
Radiation Hazard (Section 5): Artificial isotope Tm^{170}, half-life: 129 days; emits beta particles of 0.97 mev (90%) and 0.89 mev (10%) and gamma rays of 0.08 mev. The permissible levels are: In body: 19 microcuries; in air: 5×10^{-8} microcurie per milliliter; in water: 2.5×10^{-2} microcurie per milliliter.
Fire Hazard: Moderate, in the form of dust, when exposed to flame. See also Powdered Metals (Section 6).
Explosion Hazard: Slight, in the form of dust, when exposed to flame. See also Powdered Metals.

THYME OIL

Description: Corlorles to reddish-brown liquid; pleasant odor; sharp taste.
Constant:
Density 0.894 - 0.930 @25°/25°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1
Acute Systemic: U
Chronic Local: Allergen 1
Chronic Systemic: Ingestion 1; Inhalation 1
Fire Hazard: Slight; when heated, it emits acrid fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

THYMOL

Synonym: Thyme camphor.
Description: Colorless, translucent crystals.
Formula: $C_{10}H_{14}O$
Constants:
Mol. Wt. 150.2
M. P. 51°C
B. P. 233°C
Density 0.972
Vap. Press. 1 mm @64.3°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1; Ingestion 2
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: Allergen 1
Chronic Systemic: Ingestion 1
Disaster Control: Moderately dangerous; when heated, it emits toxic fumes.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

TIGLIC ACID

Synonym: Crotonalic acid.
Description: Thick, syrupy liquid or colorless crystals.
Formula: $CH_3CHC(CH_3)CO_2H$

Constants:
  Mol. Wt. 100.11
  M. P. 65°C
  B. P. 198.5°C
  Density 0.9641
  Vap. Press. 1 mm @52.0°C
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 2
  Acute Systemic: Ingestion 3
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Moderately dangerous; when heated to decomposition, it emits toxic fumes.
Personnel Hygiene: Section 3
Storage and Handling: Section 7

TIME FUZES. See Explosives, High.
Shipping Regulations: Section 11.
  I.C.C. Classification: Explosive C.
  Coast Guard Classification: Explosive C.

TIN (ALPHA)

Description: Cubic gray crystalline metal.
Formula: Sn
Constants:
  At. Wt. 118.70
  M. P. 231.9°C; stabilizes below 18°C
  B. P. 2260°C
  Density 5.75
  Vap. Press. 1 mm @1492°C
Toxicity: See Tin Compounds.
Radiation Hazard (Section 5): Artificial isotope Sn^{113}, half-life: 112 days; emits gamma rays of 0.09 mev. The permissible levels are: In body: 80 microcuries; in air: 6×10^{-7} microcurie per milliliter; in water: 0.2 microcurie per milliliter.
Fire Hazard: Slight, in the form of dust, when exposed to heat or by spontaneous chemical reaction. See also Powdered Metals (Section 6).

TIN COMPOUNDS

Toxicity: Variable. Neither tin nor any of its compounds is generally regarded as being industrially toxic. Both stannic bromide and stannic chloride (tin tetrachloride) produce irritating fumes on exposure to air due to evolution of hydrohalogen acid fumes on hydrolysis.

TIN FLUORIDE

Synonym: Stannous fluoride; tin bifluoride.
Description: White, lustrous, crystalline powder.
Formula: SnF_2
Constant:
  Mol. Wt. 156.70
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

TIN MONOPHOSPHIDE

Synonyms: Tin phosphide; stannic phosphide.
Description: Silver-white crystals.
Formula SnP
Constants:
  Mol. Wt. 149.68
  Density 6.56
For other properties, see Phosphides.

TIN OXIDE

Synonyms: Stannous oxide; stannic oxide (cassiterite).
Description: Tetragonal black powder.
Formula: SnO, SnO_2
Constants:
  Mol. Wt. 134.70
  M. P. Decomposes @700 - 950°C
  Density 6.446 @0°C
Toxicity: See Tin Compounds.

TIN TETRACHLORIDE

Synonym: Stannic chloride.
Description: Colorless liquid.
Formula: $SnCl_4$
Constants:
  Mol. Wt. 260.53
  M. P. -33°C
  B. P. 114.1°C
  Density 2.232
Toxicity: Corrosive. See Hydrochloric Acid.
Disaster Control: See Hydrochloric Acid.
Storage and Handling: Section 7

TIN TETRACHLORIDE, ANHYDROUS

Shipping Regulations: Section 11.
  I.C.C. Classification: Corrosive liquid; white label.

Coast Guard Classification: Corrosive liquid; white label.

TIN TETRAHYDRIDE

Synonym: Stannane.
Description: Gas.
Formula: SnH_4
Constants:
- Mol. Wt. 122.73
- M. P. −150°C
- B. P. −52. C (decomp.)

Toxicity: See Hydrides.
Fire Hazard: Moderate, when exposed to flame. See also Hydrides (Section 6).
Explosion Hazard: Slight, when exposed to flame. See also Hydrides.
Disaster Control: Moderately dangerous; when heated, it emits toxic fumes and may explode; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

TIN TETRAMETHYL

Synonym: Tetramethylstannane.
Description: Colorless liquid.
Formula: $Sn(CH_3)_4$
Constants:
- Mol. Wt. 178.84
- B. P. 78°C
- Density 1.314 @0°/4°C

Toxicity: See Tin Compounds.
Fire Hazard: Moderate, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 1.90% (L.E.L.)
Disaster Control: Dangerous; when heated, it emits acrid fumes and may explode; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

TIN TETRAPHENYL

Description: Liquid.
Formula: $(C_6H_5)_4Sn$
Constants: Mol. Wt. 427.1
- M. P. 226°C
- B. P. 424°C
- Flash P. 450°F (C.C.)
- Density 1.490

Toxicity: Highly toxic. See Phenol.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

TIN TRIPHOSPHIDE

Description: Crystals.
Formula: SnP_3
Constants:
- Mol. Wt. 211.64
- M. P. Decomposes < 415°C to Sn_4P_3
- Density 4.10 @0°C

For other properties, see Phosphides.

TITANIUM

Description: Dark gray, amorphous powder or white, lustrous metal.
Formula: Ti
Constants:
- At. Wt. 47.90
- M. P. 1800°C
- B. P. Above 3000°C
- Density 4.5 @20°C
- Autoign. Temp. 700 - 800°C for massive metal in air; 250°C for powder.

Toxicity: See Titanium Compounds.
Fire Hazard: Moderate, in the form of dust, when exposed to heat or flame or by chemical reaction. See also Powdered Metals (Section 6).
Shipping Regulations: Section 11.
- Coast Guard Classification: Inflammable solid; yellow label.

TITANIUM COMPOUNDS

Toxic Hazard Rating:
- Acute Local: Ingestion 1; Inhalation 1
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Toxicology: This material is considered to be physiologically inert. There are no reported cases in the literature where titanium as such has caused intoxication. The dusts of titanium or titanium compounds such as titanium oxide may be placed in the nuisance category. Titanium tetrachloride, however, is an irritating and corrosive material, because, when exposed to moisture, it hydrolyzes to hydrogen chloride. See Hydrochloric Acid.

TITANIUM DIBROMIDE
Description: Black powder.
Formula: $TiBr_2$
Constants:
  Mol. Wt. 207.73
  M. P. Decomposes > 500°C
Toxicity: See Bromides.
Disaster Control: See Bromides.
Storage and Handling: Section 7

TITANIUM DICHLORIDE
Description: Light brown to black, deliquescent solid.
Formula: $TiCl_2$
Constants:
  Mol. Wt. 118.81
  M. P. Sublimes in H_2
Toxicity: See Titanium Compounds and Hydrochloric Acid.
Fire Hazard: Moderate, when exposed to heat or flame or by chemical reaction with oxygen or air (Section 6).
Disaster Control: See Hydrochloric Acid.
Storage and Handling: Section 7

TITANIUM DIOXIDE
Synonym: Rutile.
Description: Blue crystals.
Formula: TiO_2
Constants:
  Mol. Wt. 79.90
  M. P. 1640°C (decomp.)
  Density 4.26
Toxicity: See Titanium Compounds.
MAC: ACGIH (tentative); 15 milligrams per cubic meter of air.

TITANIUM DISULFIDE
Description: Yellow scales.
Formula: TiS_2
Constant:
  Mol. Wt. 112.03
For further properties, see Sulfides.

TITANIUM HYDRIDE
Description: Metallic, dark gray powder or crystals.
Formula: TiH_2
Constants:
  Mol. Wt. 49.9
  Density 3.76
Toxicity: See Hydrides and Titanium Compounds.
Fire Hazard: Moderate, when exposed to heat or flame. Burns brilliantly in air. See Hydrides.
Explosion Hazard: Moderate, in the form of dust, by chemical reaction.
Disaster Control: See Hydrides.
Storage and Handling: Section 7

TITANIUM ISOPROPYLATE. See Isopropyl Titanate.

TITANIUM METAL POWDER, WET WITH NOT LESS THAN 20% WATER.
Shipping Regulations: Section 11.
  Coast Guard Classification:
    Inflammable solid; yellow label.

TITANIUM MONOSULFIDE
Description: Reddish solid.
Formula: TiS
Constant:
  Mol. Wt. 79.97
For other properties, see Sulfides.

TITANIUM NITRIDE
Description: Brassy crystals.
Formula: TiN
Constants:
  Mol. Wt. 62.0
  M. P. 2950°C
  Density 5.43
Toxicity: Unknown

TITANIUM OXALATE
Description: Yellow prisms.
Formula: $Ti_2(C_2O_4)_3 \cdot 10H_2O$
Constant:
  Mol. Wt. 540.02
Toxicity: See Oxalates.

TITANIUM PHOSPHIDE
Description: Gray, metallic solid.
Formula: TiP
Constants:
  Mol. Wt. 78.88
  Density 3.95 @25°C
For other properties, see Phosphides.

TITANIUM SESQUISULFIDE
Description: Grayish-black crystals.
Formula: Ti_2S_3

Constant:
Mol. Wt. 192.00
For other properties, see Sulfides.

TITANIUM TETRACHLORIDE

Description: Colorless, light yellow liquid; fumes in moist air.
Formula: $TiCl_4$
Constants:
Mol. Wt. 189.73
M. P. −30°C
B. P. 136.4°C
Density 1.722 @25°/25°C
Vap. Press. 10 mm @21.3°C
Toxicity: See Hydrochloric Acid and Titanium Compounds.
Disaster Control: See Hydrochloric Acid.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

TITANIUM TETRAFLUORIDE

Description: White powder.
Formula: TiF_4
Constants:
Mol. Wt. 123.90
B. P. 284°C
Density 2.798 @20.5°C
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

TITANIUM TRICHLORIDE

Description: Dark violet-colored in solution.
Formula: $TiCl_3$
Constants: Mol. Wt. 154.28
M. P. 440°C (decomp.)
Toxicity: See Hydrochloric Acid.
Disaster Control: See Hydrochloric Acid.
Storage and Handling: Section 7

TITANIUM TRIFLUORIDE

Description: Purple-red or violet crystals.
Formula: TiF_3
Constant:
Mol. Wt. 104.90
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

TITANOUS SULFATE

Description: Crystalline, green, deliquescent powder.
Formula: $Ti_2(SO_4)_3$
Constant:
Mol. Wt. 383.98
Toxicity: See Titanium Compounds.

TOBACCO

Description: Dried leaves.
Toxic Hazard Rating:
Acute Local: Irritant 1; Allergen 1; Inhalation 1
Acute Systemic (infusions): Ingestion 2; Inhalation 2; Skin Absorption 2
Chronic Local: Irritant 1; Allergen 1
Chronic Systemic: Inhalation 1
Remarks: See Nicotine (2).
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

TOLUENE

Synonyms: Methylbenzene; phenylmethane; toluol.
Description: Colorless liquid; benzol-like odor.
Formula: $C_6H_5CH_3$
Constants:
Mol. Wt. 92.13
M. P. −95°C to −94.5°C
B. P. 110.4°C
Flash P. 40°F (C.C.)
Density 0.866 @20°/4°C
Autoign. Temp. 1026°F
Vap. Press. 36.7 mm @30°C
Vap. D. 3.14
Toxic Hazard Rating:
Acute Local: Ingestion 2
Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 1
Chronic Local: Irritant 1
Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
MAC: 200 parts per million in air.
Toxicology: Toluene is derived from coal tar, and commercial grades usually contain small amounts of benzene as an impurity. Acute poisoning, resulting from exposures to high concentrations of the vapors, are rare with toluene. Inhalation of 200 ppm of toluene for 8 hours may cause impairment of coordination and reaction time; with higher concentrations

(up to 800 ppm) these effects are increased and are observed in a shorter time. In the few cases of acute toluene poisoning reported, the effect has been that of a narcotic, the workman passing through a stage of intoxication into one of coma. Recovery following removal from exposure has been the rule. An occasional report of chronic poisoning describes an anemia and leucopenia, with biopsy showing a bone marrow hypoplasia. These effects, however, are less common in people working with toluene, and they are not as severe.

Exposure to concentrations up to 200 ppm produces few symptoms. At 200 to 500 ppm, headache, nausea, loss of appetite, a bad taste, lassitude, impairment of coordination and reaction time are reported, but are not usually accompanied by any laboratory or physical findings of significance. With higher concentrations, the above complaints are increased, and in addition, anemia, leucopenia and enlarged liver may be found in rare cases.

Fire Hazard: Dangerous, when exposed to heat or flame.
Spontaneous Heating: No
Underwriters Laboratory Classification: 75-80
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, when exposed to flame.
Explosive Range: 1.27 - 7.0%
Disaster Control: Moderately dangerous; when heated, it emits toxic fumes; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11
  I. C. C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Inflammable liquid; red label.
  MCA warning label.

2, 4- TOLUENEDIAMINE

Synonym: Tolylenediamine.
Description: Prisms.
Formula: $CH_3C_6H_3(NH_2)_2$
Constants:
  Mol. Wt. 122.17
  M. P. 99°C
  B. P. 280°C
  Vap. Press. 1 mm @106.5°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: Ingestion 2; Inhalation 2
Toxicology: This material has a marked toxic action upon the liver and can cause fatty degeneration of that organ. It is also thought to be an irritant. When solutions of it come in contact with the skin, it can cause irritation and blisters, particularly to individuals who are sensitive to it.
Disaster Control: Moderately dangerous; when heated, it emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

2, 5-TOLUENE DIAMINE

Synonyms: 2, 5-Toluenediamine; 2, 5-diaminotoluene.
Description: Colorless, crystalline tablets.
Formula: $CH_3C_6H_3(NH_2)_2$
Constants:
  Mol. Wt. 122.17
  M. P. 64°C
  B. P. 274°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: Ingestion 2; Inhalation 2
Toxicology: This material has a toxic action upon the liver and can cause fatty degeneration of that organ. Its total effect upon the body seems to take place 3 different ways. It is toxic to the central nervous system. It produces jaundice by action on the liver and spleen, and it produces anemia by destruction of the red blood cells. In this action it is quite similar to aniline, although by no

means identical with it. Its high boiling point and the fact that the material is solid at room temperature makes it somewhat less hazardous than aniline, particularly at ordinary working temperatures. The literature contains a reference to a permanent injury to an eye due to the use of this material as an eyelash dye. It is considered to be an irritant dye material. It can cause irritation and blisters on the fingers of individuals whose skins are sensitive to it.

Disaster Control: Moderately dangerous; when heated, it emits toxic fumes.

Ventilation Control (use normal rate): Section 2

Personal Hygiene: Section 3

Storage and Handling: Section 7

TOLUENE SUBSTITUTE

Description: Composes largely of octanes.

Constants: B. P. 100°C

Flash P. 30°F

Density 0.743

Toxicity: See Octane.

Fire Hazard: Dangerous, when exposed to heat or flame.

To Fight Fire: Foam, carbon dioxide or dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Unknown

Disaster Control: Dangerous, upon exposure to heat or flame; can react vigorously with oxidizing materials.

Storage and Handling: Section 7

o-TOLUENE SULFONIC ACID

Synonym: Methyl benzene sulfonic acid.

Description: Crystals.

Formula: $CH_3C_6H_4SO_3H$

Constant: Mol. Wt. 172.2

Toxicity: Details unknown. See also Sulfonic Acid.

Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur.

Storage and Handling: Section 7

p-TOLUENE SULFONYLAMIDE

Toxicity: Details unknown; fungicide.

Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of sulfur.

Storage and Handling: Section 7

m-TOLUIDINE

Synonym: m-Methylaniline.

Description: Colorless liquid.

Formula: $CH_3C_6H_4NH_2$

Constants: Mol. Wt. 107.2

M. P. −31.5°C

B. P. 203.3°C

Density 0.989 @20°/4°C

Vap. Press. 1 mm @41°C

Vap. D. 3.90

Toxicity: See o-Toluidine.

MAC: ACGIH (accepted); 5 parts per million in air; 22 milligrams per cubic meter of air.

Fire Hazard: Moderate, when exposed to heat or flame.

To Fight Fire: Foam, carbon dioxide or dry chemical or carbon tetrachloride.

Disaster Control: Dangerous, when heated, it emits highly toxic fumes; can react vigorously on contact with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

MCA warning label.

o-TOLUIDINE

Synonym: o-Methylaniline.

Description: Colorless liquid.

Formula: $CH_3C_6H_4NH_2$

Constants: Mol. Wt. 107.2

M. P. −16.3°C

B. P. 199.7°C

Flash P. 185°F (C.C.)

Density 1.004 @20°/4°C

Autoign. Temp. 900°F

Vap. Press. 1 mm @44°C

Vap. D. 3.69

Toxic Hazard Rating:

Acute Local: Irritant 2; Allergen 1; Ingestion 2

Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3

Chronic Local: Allergen 1

Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2

MAC: ACGIH (accepted); 5 parts per million in air; 22 milligrams per cubic meter of air.

Toxicology: This material can produce severe systemic disturbances. The main portal of entry into the body is the respiratory tract, particularly in cases of industrial exposure. The symptoms produced by intoxication due to this compound are headache, weakness, difficulty in breathing, air-hunger, psychic disturbances, and marked irritation of the kidneys and bladder. The literature does not yield any good data for comparing the toxicities of the ortho, meta and para isomers. Their behavior is generally comparable to that of aniline, and while the most frequent type of exposure is inhalation, a certain amount of exposure occurs by skin contact. It has been determined experimentally that a concentration of approximately 100 ppm is the maximum endurable for an hour without serious consequences, and that from 6 to 23 ppm is endurable for several hours without serious disturbance. See Aniline.

Fire Hazard: Moderate, when exposed to heat or flame.
Spontaneous Heating: No
Underwriters Laboratory Classification: 20-25
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated, it emits highly toxic fumes; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
MCA warning label.

p- TOLUIDINE

Synonym: p-Methylaniline.
Description: Colorless leaflets.
Formula: $CH_3C_6H_4NH_2$
Constants: Mol. Wt. 107.2
M. P. 44.5°C
B. P. 200.4°C
Flash P. 188°F (C.C.)
Density 1.046 @20°/4°C
Autoign. Temp. 900°F
Vap. Press. 1 mm @42°C
Vap. D. 3.90
Toxicity: See o-Toluidine.
MAC: ACGIH (accepted); 5 parts per million in air; 22 milligrams per cubic meter of air.
Fire Hazard: Moderate, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide or dry chemical or carbon tetrachloride.
Disaster Control: Dangerous; when heated, it emits highly toxic fumes; can react vigorously on contact with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7
MCA warning label.

o-TOLUOL SULFOACID

Description: Liquid.
Formula: $C_{14}H_{14}O_3S$
Constants:
Mol. Wt. 262.32
Flash P. 363°F
Toxicity: Unknown.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of sulfur; can react with oxidizing materials.
Storage and Handling: Section 7

o-TOLYL BIGUANIDE HYDROCHLORIDE

Description: Colorless crystals.
Formula:
$CH_3C_6H_4NHC(NH)NHC(NH)NH_2 \cdot HCl$
Constants: Mol. Wt. 227.5
M. P. 227°C
Density 1.264 @30°C
Toxicity: Unknown.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes.
Storage and Handling: Section 7

p-TOLYL DIETHANOLAMINE

Description: Crystals.
Formula: $(HOC_2H_4)_2NC_6H_4CH_3$
Constants:
Mol. Wt. 195.25
M. P. 63.2°C

Flash P. 385°F (O. C.)
Vap. D. 6.73

Toxicity: Details unknown. See also Amines.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

TOLYLENE DIISOCYANATE

Synonym: Toluene diisocyanate.

Description: Liquid or crystals.

Formula: $C_6H_3CH_3(NCO)_2$

Constants:
Mol. Wt. 174.2
B. P. 120°C @10 mm
Freezing P. 19.5 - 21.5°C
Density 1.22 @25°C
Vap. D. 6.01

Toxicity: See Isocyanates.

Disaster Control: See Isocyanates.

Storage and Handling: Section 7

2,4-TOLYLENE DIISOCYANATE

Description: Clear faintly yellow liquid.

Formula: $H_3CC_6H_3(NCO)_2$

Constants:
Mol. Wt. 174.16
B. P. 118 - 120°C at 10 mm
Freezing P. 20°C
Density 1.22 @20°/4°C

Toxicity: Details unknown; a local irritant; can act as a mild sensitizing agent.

Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes.

Storage and Handling: Section 7

o-TOLYL ETHANOLAMINE

Description: Liquid.

Formula: $CH_3C_6H_4NHCH_2CH_2OH$

Constants:
Mol. Wt. 151.2
M. P. -25°C
B. P. 297.1°C
Flash P. 290°F (O. C.)
Density 1.0723 @20°/20°C

Toxicity: Details unknown. See also Amines.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

TOLYL MERCURY SALICYLATE

Toxicity: See Mercury Compounds, Organic.

Disaster Control: See Mercury Compounds, Organic.

Storage and Handling: Section 7

o-TOLYL PROPANOLAMINE

Description: Liquid.

Formula: $CH_3C_6H_4NHCH_2CHOHCH_3$

Constants:
Mol. Wt. 165.2
B. P. 170 - 180°C @20 mm
Vap. D. 5.7

Toxicity: Details unknown. See also Amines.

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).

Storage and Handling: Section 7

o-TOLYL p-TOLUENE SULFONATE

Description: Liquid.

Formula: $C_{14}H_{14}O_3S$

Constants:
Mol. Wt. 262.31
Flash P. 363°F (C. C.)

Toxicity: Unknown.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

"TOXAPHENE"

Synonym: Chlorinated camphene.

Description: Yellow, waxy solid.

Formula: $C_{10}H_{10}Cl_8$

Constants:
Mol. Wt. 413.84
M. P. 65 - 90°C

Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3

Caution: The Food and Drug Administration (1955) proposes a tolerance of 7 ppm for residues on fruits and vegetables.

Toxicology: Toxic and in some instances lethal amounts of toxaphene can enter the body through the mouth, lungs, and skin. Systemic absorption of the insecticide is increased by the presence of digestible oils and liquid preparations of the insecticide penetrate the skin more readily than do dusts and wettable powders.

Toxaphene resembles chlordane and to some extent camphor in its physiological action. It causes diffuse stimulation of the brain and spinal cord resulting in generalized convulsions of a tonic or clonic character. Death usually results from respiratory failure. Detoxification appears to occur in the liver.

Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

TOY CAPS. See Explosives, Low.
Shipping Regulations: Section 11.
  I. C. C. Classification: Explosive C.
  Coast Guard Classification: Explosive C.

TRACERS. See Explosives, Low.
Shipping Regulations: Section 11.
  I. C. C. Classification: Explosive C.
  Coast Guard Classification: Explosive C.

TRACERS FUZES. See Explosive, High.
Shipping Regulations: Section 11.
  I. C. C. Classification: Explosive C.
  Coast Guard Classification: Explosive C.

TRAGACANTH

Synonym: Gum tragacanth.
Description: Powder is white; pieces are white to pale yellow, translucent and horny.
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: Ingestion 1; Inhalation 1
  Chronic Local: Allergen 1
  Chronic Systemic: Ingestion 1; Inhalation 1
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

TRANSFORMER OIL

Synonym: Transil oil.
Description: Liquid.
Constants:
  Flash P. 295°F (O. C.)
  Density 0.9
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Slightly dangerous; when heated it emits acrid fumes; can react with oxidizing materials.
Storage and Handling: Section 7

"TRANSOTE." See Creosote.

TREMETOL

Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3; Inhalation 3
  Chronic Systemic: U
Caution: Found in Rich-wheat or Snake-root. Can occur in milk of cows that have eaten either of these.

TRIALLYL CYANURATE

Description: Colorless liquid or solid.
Formula: $C_{12}H_{15}O_3N_3$
Constants:
  Mol. Wt. 249.26
  B. P. 120°C @5 mm
  Freezing P. 27.3°C
  Flash P. > 176°F (T.O.C.)
  Density 1.1133 @30°C
  Vap. Press. 1 mm @100°C
Toxic Hazard Rating:
  Acute Local: Ingestion 2; Inhalation 2
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, when

exposed to heat or flame (Section 6).

Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of cyanides.

Ventilation Control (use normal rate): Section 2

Personal Hygiene: Section 3

Storage and Handling: Section 7

TRIAMYLAMINE

Description: A clear, water-white or pale yellow liquid; amine odor.

Formula: $(C_5H_{11})_3N$

Constants: Mol. Wt. 227.42
B. P. 232°C
Vap. Press. 7 mm @26°C
Flash P. 190°F (O.C.)
Density 0.79 - 0.80 @20°/20°C
Vap. D. 7.83

Toxicity: Details unknown. See Amines.

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.

Disaster Control: Moderate, when heated to decomposition it emits toxic fumes.

Storage and Handling: Section 7

TRIAMYL BENZENE

Description: A clear liquid.

Formula: $(C_5H_{11})_3C_6H_3$

Constants:
Mol. Wt. 288.50
B. P. 300°C
Flash P. 270°F (O.C.)
Density 0.87

Toxicity: Details unknown. See Benzene.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

Spontaneous Heating: No

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

TRIAMYL BORATE

Synonym: Tri-N-amyl borate.

Description: A clear liquid; odor of n-amyl alcohol.

Formula: $B(C_5H_{11}O)_3$

Constants:
Mol. Wt. 272.23
B. P. 110 - 114°C @2 mm
Flash P. 265°F
Density 0.852 @27°C
Vap. D. 9.4

Toxicity: See Boron Compounds and Amyl Alcohol.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

Spontaneous Heating: No

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

TRI-2-BIPHENYLYL PHOSPHATE

Description: White, granular solid.

Formula: $(C_6H_5C_6H_4)_3PO_4$

Constants:
Mol. Wt. 554.6
M. P. 113 - 115°C

Toxicity: See Phosphorus Compounds.

Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of phosphorus.

Storage and Handling: Section 7

TRIBORON SILICIDE

Description: Rhombic, black crystals.

Formula: B_3Si

Constants: Mol. Wt. 60.52
Density 2.52

Toxicity: Details unknown. See Boron Compounds.

Fire Hazard: Moderate, by chemical reaction. Reacts with moisture to liberate hydrogen.

Explosion Hazard: Moderate, in the form of dust by chemical reaction with oxidizers.

Disaster Control: Moderately dangerous; will react with water or steam to produce heat and hydrogen.

Storage and Handling: Section 7

TRIBROMOETHANOL

Description: Crystals.

Formula: CBr_3CH_2OH

Constants: Mol. Wt. 282.8
M. P. 79 - 82°C
B. P. 92 - 93°C @10 mm

Toxicity: Details unknown. See Bromides and Alcohols.

Disaster Control: Moderately dangerous; when heated to

decomposition it emits toxic fumes of bromides.
Storage and Handling: Section 7

TRIBROMOGERMANE

Synonym: Germanium bromoform.
Description: Colorless liquid.
Formula: $GeHBr_3$
Constants:
Mol. Wt. 313.36
M. P. −24.0°C
B. P. Decomposes
Toxicity: Details unknown. See Bromides and Germanium Compounds.

TRI-N-BROMOMELAMINE

Description: White powder.
Formula: $Br_3C_3H_3N_6$
Constant: Mol. Wt. 362.9
Toxicity: Details unknown; probably toxic.
Explosion Hazard: Slight, by chemical reaction or on contact with allyl alcohol at room temperature.
Disaster Control: Moderately dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits toxic fumes of bromides.
Storage and Handling: Section 7

1,1,1-TRIBROMO-2-METHYL-2-PROPANOL

Description: Fine white crystals.
Formula: $CBr_3C(CH_3)_2OH$
Constants: Mol. Wt.
Mol. Wt. 310.8
M. P. 176 - 177°C
Toxicity: Details unknown; probably toxic.
Disaster Control: Moderately dangerous; when heated to decomposition, it can emit highly toxic fumes of bromides.
Storage and Handling: Section 7

TRIBUTOXY ETHYL PHOSPHATE

Description: Light-colored liquid with butyl-like odor.
Formula: $(C_4H_9OC_2H_4O)_3PO$
Constants:
Mol. Wt. 398
M. P. −70°C
B. P. 200 - 230°C @4 mm
Flash P. 435°F
Density 1.02 @20°/20°C
Vap. Press. 0.03 mm @150°C
Vap. D. 13.8
Toxicity: Details unknown.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of phosphorus; can react with oxidizing materials.
Storage and Handling: Section 7

TRIBUTYLAMINE

Description: A colorless liquid.
Formula: $(C_4H_9)_3N$
Constants:
Mol. Wt. 185.35
M. P. −70°C
B. P. 213°C
Flash P. 185°F (O.C.)
Density 0.78 - 0.79
Vap. D. 6.38
Toxicity: Details unknown. See Amines.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderate; when heated to decomposition it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

TRI-n-BUTYL BORATE

Description: Colorless, mobile liquid. Odor like n-butyl alcohol.
Formula: $B(OC_4H_9)_3$
Constants:
Mol. Wt. 230.16
B. P. 230°C
Freezing P. < −70°C
Flash P. 200°F (C.O.C.)
Density 0.847 @28°C
Vap. D. 7.95
Toxicity: See Boron Compounds and n-Butanol.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition or on contact with acid or acid fumes, it can emit toxic fumes; on contact with oxidizing

materials, it can react vigorously.
Storage and Handling: Section 7

TRI-sec-BUTYL BORATE

Description: Colorless liquid, odor of sec-butanol.
Formula: $[CH_3CH_2C(CH_3)OH]_3B$
Constants:
Mol. Wt. 230.16
B. P. 184 - 192°C
Flash P. 165°F (C.O.C.)
Density 0.829 @24°C
Toxicity: See Boron Compounds and sec-Butanol.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TRIBUTYL CITRATE

Description: A liquid.
Formula: $(CH_2COOC_4H_9)_2COHCOOC_4H_9$
Constants:
Mol. Wt. 360.44
M. P. −20°C
B. P. 232°C
Flash P. 315°F (C.O.C.)
Density 1.042 @25°/25°C
Autoign. Temp. 695°F
Vap. D. 12.41
Toxicity: See Butyl Alcohol and Citric Acid.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TRIBUTYL PHOSPHATE

Description: Colorless, odorless liquid.
Formula: $(C_4H_9)_3PO_4$
Constants:
Mol. Wt. 266.32
M. P. < −80°C
B. P. 292°C
Flash P. 295°F (C.O.C.)
Density 0.982 @20°C
Vap. D. 9.20
Toxicity: See Butyl Alcohol and Phosphoric Acid.
Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of phosphorus and on contact with oxidizing materials, it can react vigorously.
Storage and Handling: Section 7

TRIBUTYL PHOSPHINE OXIDE

Description: Crystals.
Formula: $(C_4H_9)_3PO$
Constant:
Mol. Wt. 218.3
Toxicity: Details unknown; possibly quite high; has been known to damage the eyes of experimental animals.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of phosphorus.
Storage and Handling: Section 7

TRIBUTYL PHOSPHITE

Toxicity: Has been known to damage the eyes of experimental animals. See Phosphorous Acid and Butanol.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of phosphorus.
Storage and Handling: Section 7

TRIBUTYL PHOSPHOROTHIOATE

Description: Colorless liquid, mild characertistic odor.
Formula: $(C_4H_9O)_3PS$
Constants:
Mol. Wt. 282.3
B. P. 142 - 145°C @4.5 mm
Flash P. 295°F (C.O.C.)
Density 0.987 @20°/4°C
Toxicity: Details unknown; probably moderate.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of phosphorous and oxides of sulfur; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

TRIBUTYRIN

Synonym: Glyceryl tributyrate.

Formula: $C_{15}H_{26}O_6$
Constants: Mol. Wt. 302.4
M. P. -75°C
B. P. 312 - 315°C
Density 1.0356 @20°/20°C
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

TRICHLORACETIC ACID

Description: Colorless, rhombic deliquescent crystals.
Formula: CCl_3COOH
Constants:
Mol. Wt. 163.40
B. P. 197.5°C
Freezing P. 57.5°C
Flash P. None
Density 1.6298 @61°/4°C
Vap. Press. 1 mm @51.0°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

TRICHLOROACETONITRILE

Synonym: Chlorocyanohydrin.
Description: Crystals; odor of HCN.
Formula: $Cl_3CH(OH)CN$
Constants:
Mol. Wt. 174.4
M. P. 61°C
B. P. 220°C
Toxicity: See Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7

TRICHLOROACETYL CHLORIDE

Synonym: Superpalite.
Description: Liquid.
Formula: CCl_3COCl
Constants:
Mol. Wt. 181.86
B. P. 118°C
Density 1.629 @16°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Ingestion 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Caution: A military poison.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

TRICHLOROACETYL CHLOROETHYLAMIDE

Toxicity: Details unknown; a mosquito repellent.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

1, 2, 3-TRICHLOROBENZENE

Description: White crystals.
Formula: $C_6H_3Cl_3$
Constants:
Mol. Wt. 181.5
M. P. 52.6°C
B. P. 221°C
Flash P. 235°F (C.C.)
Density 1.69 @25°/25°C
Vap. Press. 1 mm @40.0°C
Vap. D. 6.26
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: Causes loss of hair of experimental animals.
Chronic Systemic: Ingestion 2; Inhalation 2
Fire Hazard: Slight; when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

1,2,4-TRICHLOROBENZENE
Synonym: uns-Trichlorobenzene.
Description: Colorless liquid.
Formula: $C_6H_3Cl_3$
Constants:
  Mol. Wt. 181.5
  M. P. 17°C
  B. P. 213°C
  Flash P. 230°F (C.C.)
  Density 1.454 @25°/25°C
  Vap. Press. 1 mm @38.4°C
  Vap. D. 6.26
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: Ingestion 2; Inhalation 2
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

1,3,5-TRICHLOROBENZENE
Synonym: sym-Trichlorobenzene.
Description: White crystals.
Formula: $C_6H_3Cl_3$
Constants:
  Mol. Wt. 181.5
  M. P. 63.4°C
  B. P. 208.5°C
  Flash P. 225°F (C.C.)
  Vap. Press. 10 mm @78.0°C
  Vap. D. 6.26
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: Causes loss of hair of experimental animals.
  Chronic Systemic: Ingestion 2; Inhalation 2
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, or dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

1-TRICHLORO-2,2-BIS(p-BROMOPHENYL) ETHANE
Synonym: Bromine analog of D.D.T.
Description: Crystals
Formula: $(BrC_6H_4)_2CHCCl_3$
Constants:
  Mol. Wt. 443.4
Toxicity: Details unknown; a pesticide. See D.D.T.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides and bromides.
Storage and Handling: Section 7

1-TRICHLORO-2,2-BIS(p-FLUOROPHENYL) ETHANE
Synonym: Fluorine analog of D.D.T.
Description: Crystals.
Formula: $(FC_6H_4)_2CHCCl_3$
Constant:
  Mol. Wt. 321.6
Toxicity: Details unknown; probably highly toxic. A pesticide. See also D.D.T.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides and fluorides.
Storage and Handling: Section 7

1-TRICHLORO-2,2-BIS(p-METHOXYPHENYL) ETHANE
Synonym: Methoxy analog of D.D.T.; DMDT.
Description: Crystals.
Formula: $(CH_3OC_6H_4)_2CHCCl_3$
Constant:
  Mol. Wt. 345.6
Toxicity: Details unknown; a pesticide. See also D.D.T.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

TRICHLOROBUTANE
Description: Liquid.
Formula: $Cl_3C_4H_7$

Constants:
Mol. Wt. 154.5
B. P. 168°C
Flash P. 195°F
Toxicity: Details unknown. See Chlorinated Hydrocarbons.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decompositon it emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

α,α,β-TRICHLOROBUTYRAMIDE

Description: Crystals.
Formula: $CH_3CHClCCl_2CONH_2$
Constant:
Mol. Wt. 190.5
Toxicity: Details unknown; a pesticide; stomach insecticide.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

TRICHLOROCHLOROPHENYL PHENYLETHANE

Description: Crystals.
Constant:
Mol. Wt. 320.1
Toxicity: Details unknown; an insecticide.
Disaster Control: Dangerous; when heated to decompositon it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

1-TRICHLORO-2-(p-CHLOROPHENYL)-2-PHENYLETHANE

Formula: $(ClC_6H_5)(C_6H_5)CHCCl_3$
Constant:
Mol. Wt. 333.1
Toxicity: Details unknown; a pesticide.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

1,2,4-TRICHLORO-3,5-DINITROBENZENE

Formula: $Cl_3C_6H(NO_2)_2$
Constant:
Mol. Wt. 271.5
Toxicity: Details unknown; a pesticide. See also Chlorobenzene and Nitrobenzene.
Fire Hazard: Moderate, when exposed to heat or flame. See also Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of nitrogen and chlorides; can react vigorously with reducing materials.
Storage and Handling: Section 7

α-TRICHLOROETHANE

Synonyms: 1,1,1-Trichloroethane; methyl chloroform.
Description: Colorless liquid.
Formula: CH_3CCl_3
Constants:
Mol. Wt. 133.42
B. P. 74.1°C
Freezing P. −32.5°C
Flash P. None
Density 1.3492 @20°/4°C
Vap. Press. 100 mm @20.0°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 2
Acute Systemic: Inhalation 2
Chronic Local: Irritant 1
Chronic Systemic: Ingestion 2; Inhalation 2
MAC: ACGIH (accepted); 500 parts per million in air; 2720 milligrams per cubic meter of air.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

β-TRICHLOROETHANE

Synonyms: 1,1,2-Trichloroethane; vinyl trichloride.
Description: Liquid, pleasant odor.
Formula: $CH_2ClCHCl_2$
Constants:
Mol. Wt. 133.4
B. P. 114°C
Freezing P. −35°C
Density 1.4416 @20°/4°C
Vap. Press. 40 mm @35.2°C
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: Inhalation 2

Chronic Local: Irritant 1
Chronic Systemic: Ingestion 2; Inhalation 2
Toxicology: Trichloroethane has narcotic properties and acts as a local irritant to the eyes, nose and lungs. It may also be injurious to the liver and kidneys. A fumigant.
MAC: ACGIH (accepted); 100 parts per million of air; 545 milligrams per cubic meter of air.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

TRICHLOROETHANOL
Description: Liquid.
Formula: CCl_3CH_2OH
Constants:
Mol. Wt. 149.5
M. P. 17.8°C
B. P. 150°C @765 mm
Density 1.54 @25°/4°C
Vap. Press. 1 mm @20°C
Vap. D. 5.16
Toxicity: Details unknown; moderately toxic; anesthetic.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

TRICHLOROETHYLENE
Synonyms: Ethinyl trichloride; ethylene trichloride.
Description: Stable, colorless, heavy, mobile liquid, chloroform-like odor.
Formula: $CHClCCl_2$
Constants: Mol. Wt. 131.40
M. P. -73°C
B. P. 86.9°C
Freezing P. -86.8°C
Density 1.45560 @25°/4°C
Autoign. Temp. 770°F
Vap. Press. 40 mm @11.9°C
Vap. D. 4.53
Flash P. None
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1; Inhalation 1
Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Chronic Local: Irritant 1
Chronic Systemic: U
MAC: ACGIH (accepted); 200 parts per million in air; 1072 milligrams per cubic meter of air.
Fire Hazard: Slight, when exposed to heat or flame. High concentrations of trichloroethylene vapor in high-temperature air can be made to burn mildly if plied with a strong flame. Though such a condition is difficult to produce, flames or arcs should not be used in closed equipment which contains any solvent residue or vapor.
Spontaneous Heating: No
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
MCA warning label.

TRICHLOROFLUOROGERMANE
Description: Colorless liquid.
Formula: $GeCl_3F$
Constants:
Mol. Wt. 197.97
M. P. -49.8°C
B. P. 37.5°C
Toxicity: See Fluorides and Germanium Compounds.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

TRICHLOROGERMANE
Synonym: Germanium chloroform.
Description: Colorless liquid.
Formula: $GeHCl_3$
Constants:
Mol. Wt. 179.98
M. P. -71.0°C
B. P. 75.2°C
Density 1.93 @0°C
Toxicity: See Hydrochloric Acid and Germanium Compounds.
Disaster Control: Dangerous; when heated it emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

TRICHLOROMETHANE SULFENYL CHLORIDE. See Perchloromethyl Mercaptan.

TRICHLOROMETHYLCHLOROFORMATE.

Synonym: Diphosgene.
Description: Colorless liquid.
Formula: $ClCOOCCl_3$
Constants:
  Mol. Wt. 197.85
  M. P. -57°C
  B. P. 127.5°C
  Density 1.653 @14°/4°C
  Vap. Press. 10.3 mm @20°C
  Vap. D. 6.9
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; shock can shatter the compressed gas container, releasing the contents; when heated to decomposition it emits highly toxic fumes; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

TRICHLOROMETHYL ETHER

Description: A liquid of pungent odor.
Formula: $CHCl_2OCH_2Cl$
Constants:
  Mol. Wt. 149.41
  B. P. 130 - 132°C
  Density 1.5066 @10°C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; shock can shatter the compressed gas container, releasing the contents; when heated to decomposition, it emits highly toxic fumes; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use normal rate): Section 2
Personal Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

N-TRICHLOROMETHYL THIOTETRAHYDROPHTHALIMIDE

Toxicity: Details unknown; a fungicide.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides and oxides of sulfur.
Storage and Handling: Section 7

TRICHLORONAPHTHALENE

Description: A white solid.
Formula: $C_{10}H_5Cl_3$
Constant:
  Mol. Wt. 231.51
Toxic Hazard Rating:
  Acute Local: Irritant 2
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: Irritant 2
  Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
MAC: ACGIH (accepted); 5 milligrams per cubic meter of air.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

TRICHLORONITROMETHANE. See Nitrotrichloromethane.

TRICHLORONITROPROPANOL

Description: Crystalline solid.
Formula: $CCl_3CHOHCH_2NO_2$
Constants:
  Mol. Wt. 208.4
  M. P. 40°C
  B. P. 120°C @5 mm
  Flash P. 352°F (O.C.)
  Density 1.605 @45°/4°C
  Vap. Press. 0.1 mm @20°C
Toxicity: See Alcohols and Chlorinated Hydrocarbons.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of nitrogen and chlorides.
Storage and Handling: Section 7

TRICHLORONITROSOMETHANE

Description: Dark-blue liquid; unpleasant odor.
Formula: CCl_3NO

Constants:
  Mol. Wt. 148. 39
  B. P. 5 °C @70 mm
  Density 1. 5 @20 °C
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Caution: A lachrymator type military poison.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides and oxides of nitrogen; will react with water or steam to produce toxic and corrosive fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

2, 3, 5-TRICHLOROPHENOL

Description: Colorless needles.
Formula: $Cl_3C_6H_2OH$
Constants:
  Mol. Wt. 197. 5
  M. P. 62 °C
  B. P. 253 °C
Toxic Hazard Rating: See Chlorinated Phenols.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7
MCA warning label

2, 4, 5-TRICHLOROPHENOL

Description: Colorless needles or gray flakes.
Formula: $C_6H_2Cl_3OH$
Constants:
  Mol. Wt. 197. 5
  B. P. 252 °C
  Freezing P. 57. 0 °C
  Density 1. 678 @25°/4 °C
  Vap. Press. 1 mm @72. 0 °C
Toxicity: A seed disinfectant and fungicide. See Chlorinated Phenols.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
MCA warning label

2, 4, 6-TRICHLOROPHENOL

Description: Colorless needles or yellow solid; strong phenolic odor.
Formula: $Cl_3C_6H_2OH$
Constants: Mol. Wt. 197. 5
  M. P. 68 °C
  B. P. 244. 5 °C
  Freezing P. 62 °C
  Density 1. 490 @75°/4 °C
  Vap. Press. 1 mm @76. 5 °C
Toxicity: A seed disinfectant and fungicide. See Chlorinated Phenols.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
MCA warning label

2, 4, 5 TRICHLOROPHENOXY ACETIC ACID

Synonym: 2, 4, 5-T.
Description: Crystals; light tan solid.
Formula: $Cl_3C_6H_2OCH_2COOH$
Constants:
  Mol. Wt. 255. 5
  M. P. 151 - 153 °C
Toxicity: Details unknown; an herbicide. See 2, 4, D.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

2, 4, 5-TRICHLOROPHENYL ACETATE

Description: Crystals.
Formula: $Cl_3C_6H_2OOCCH_3$
Constant:
  Mol. Wt. 239. 5
Toxicity: Details unknown; a fungicide.
Disaster Control: Dangerous when heated to decomposition it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

TRI-o-CHLOROPHENYL BORATE

Description: White solid; odor of o-chlorophenol.

Formula: $(ClC_6H_4O)_3B$

Constants:

Mol. Wt. 399.15

M. P. 47 - 49°C

B. P. 264 - 270°C @14 mm

Toxicity: See o-Chlorophenol and Boron Compounds.

Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.

Storage and Handling: Section 7

TRICHLOROPHENYL MONOCHLOROACETATE

Description: Crystals.

Formula: $Cl_3C_6H_2OOCCH_2Cl$

Constant:

Mol. Wt. 274.0

Toxicity: See Monochloroacetic Acid and Trichlorophenol.

Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.

Storage and Handling: Section 7

1, 2, 3-TRICHLOROPROPANE

Synonyms: Glycerol trichlorohydrin; allyl trichloride trichlorohydrin.

Description: Colorless liquid.

Formula: $CH_2ClCHClCH_2Cl$

Constants:

Mol. Wt. 147.44

M. P. -14.7°C

B. P. 156.17°C

Flash P. 174°F (T.O.C.)

Density 1.3888 @20°C

Autoign. Temp. 579°F (commercial)

Vap. Press. 10 mm @46°C

Vap. D. 5.0

Toxic Hazard Rating:

Acute Local: Irritant 3; Inhalation 3

Acute Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2

Chronic Local: Irritant 3

Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2

Caution: A lipoid solvent. Cumulative toxicity. See also Chlorinated Hydrocarbons.

Fire Hazard: Moderate, when exposed to heat or flame.

Underwriters Laboratory Classification: 20 - 25.

To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosive Range: 3.2 to 12.6% (in air @150°C).

Disaster Control: Dangerous; when heated to decomposition it burns and emits highly toxic fumes of chlorides; can react vigorously with oxidizing materials.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

TRICHLOROSILANE

Synonym: Silicochloroform.

Description: Colorless, very volatile liquid.

Formula: $SiHCl_3$

Constants:

Mol. Wt. 135.44

M. P. -134°C

B. P. 31.8°C

Flash P. < 20°F (O. C.)

Density 1.35 @0°C

Vap. Press. 400 mm @14.5°C

Vap. D. 4.7

Toxic Hazard Rating:

Acute Local: Irritant 2; Inhalation 2

Acute Systemic: Ingestion 2; Inhalation 2

Chronic Local: U

Chronic Systemic: U

Fire Hazard: Dangerous, when exposed to flame or by chemical reaction. Spontaneously flammable in air.

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride.

Explosion Hazard: Unknown

Disaster Control: Dangerous; shock can shatter the container, releasing the contents; when heated to decomposition it emits highly toxic fumes of chlorides; will react with water or steam to produce heat, toxic and corrosive fumes; on contact with oxidizing materials, it can react vigorously.

Ventilation Control: (use moderate rate): Section 2

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations: Section 11.

I.C.C. Classification: Flammable liquid; red label.

Coast Guard Classification: Inflammable liquid; red label.

TRICHLOROTRIFLUOROETHANE.
See Trifluorotrichloroethane.

TRI-COPPER ANTIMONIDE
Description: Gray crystals.
Formula: Cu_3Sb
Constants: Mol. Wt. 312.38
M. P. 687°C
Density 8.51
Toxicity: See Antimony and Copper Compounds.
Fire Hazard: Moderate, by chemical reaction with moisture to evolve antimony hydride. See also Stibine.
Explosion Hazard: Slight, by chemical reaction with powerful oxidizers. See also Stibine.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of antimony; it will react with water or steam to produce toxic and flammable vapors.
Storage and Handling: Section 7

TRI-COPPER ARSENIDE
Synonym: Domeykite.
Description: Hexagonal crystals.
Formula: Cu_3As
Constants:
Mol. Wt. 265.53
M. P. 830°C
Density 8.0
Toxicity: See Arsenic Compounds.
Fire Hazard: See Arsenides.
Explosion Hazard: See Arsenides.
Disaster Control: See Arsenides.
Storage and Handling: Section 7

11-TRICOSENE
Description: A liquid.
Formula: $C_{10}H_{21}CCC_{11}H_{23}$
Constants:
Mol. Wt. 322
B. P. 168 - 170°C @2.5 mm
Flash P. 284°F
Density 0.80
Toxicity: Unknown.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TRI-m,p-CRESYL BORATE
Description: Straw-yellow, viscous liquid; characteristic odor.
Formula: $(CH_3C_6H_4OH)_3B$
Constants:
Mol. Wt. 335.2
B. P. 179 - 210°C @0.1 mm
Flash P. 240°F (C.O.C.)
Density 1.053 @27.6°C
Vap. D. 11.6
Toxicity: See Cresol and Boric Acid.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

TRI-o-CRESYL BORATE
Description: Straw-yellow liquid; odor of o-cresol.
Formula: $(CH_3C_6H_4OH)_3B$
Constants:
Mol. Wt. 335.2
B. P. 189 - 195°C @2 mm
Flash P. 345°F (C.O.C.)
Density 1.079 @22°C
Vap. D. 11.4
Toxicity: See o-Cresol and Boron Compounds.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

TRICRESYL PHOSPHATE
Synonyms: o-Tolyl phosphate.
Description: Colorless liquid.
Formula: $(CH_3C_6H_4)_3PO_4$
Constants:
Mol. Wt. 368.36
M. P. −25 to −30°C
B. P. 410°C (slight decomp.)
Flash P. 460°F (C.C.)

Density 1.17
Autoign. Temp. 725°F
Vap. D. 12.7

Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 2; Skin Absorption 2
Chronic Local: U
Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2

Toxicology: Most of the cases of tri-o-cresyl phosphate poisoning have followed its ingestion. In 1930, some 15,000 persons were affected in the United States, and of these, 10 died. The responsible material was found to be an alcoholic drink known as Jamaica ginger, or "jake." This beverage had been adulterated with about 2% of tri-o-cresyl phosphate. The affected persons developed a polyneuritis, which progressed, in many cases, with degeneration of the peripheral motor nerves, the anterior horn cells and the pyramidal tracts. Sensory changes were absent. Since 1930 there have been several other outbreaks of poisoning following ingestion of the material. Recently 3 cases of polyneuritis occurring in England in connection with the manufacture of the tri-o-cresyl phosphate have been reported. Absorption was probably through the respiratory tract, though there may have been some absorption through the skin. All three men made a good recovery.

From ingestion experiments with cockerels, it appears that tri-ortho-cresyl phosphate is more toxic than the meta form, and much more so than tri-p-cresyl phosphate or triphenyl phosphate.

Irrespective of whether absorption has been by ingestion or by inhalation or skin absorption, the history is usually one of early, transient gastro-intestinal upset, with nausea, vomiting, diarrhea and abdominal pain. These clear up, and are followed in 1 to 3 weeks by soreness of the lower leg muscles, "numbness" of the toes and fingers, and a few days later by weakness of the toes and bilateral foot-drop. After another week or so, weakness of the fingers and bilateral wrist-drop follow. There are no sensory changes. Recovery is slow, and the degree of residual paralysis depends upon the extent of damage to the nervous system. Many cases recover completely.

Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of phosphorus; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

TRICYCLOHEXYLBORATE

Description: Large needle-like white crystals. Nearly odorless.
Formula: $[\underline{CH_2(CH_2)_4C}HO]_3B$
Constants:
Mol. Wt. 308.3
M. P. 59 - 61°C
B. P. 330°C
Toxicity: See Boron Compounds.
Fire Hazard: Slight, when exposed to heat or flame.
Storage and Handling: Section 7

TRI-(2-CYCLOHEXYLCYCLOHEXYL) BORATE

Description: White solid; odor of 2-cyclohexylcyclohexanol.
Formula: $(C_{12}H_{21}O)_3B$
Constants:
Mol. Wt. 554.7
M. P. 172 - 175°C
B. P. 230 - 250°C @ 0.3 mm
Toxicity: See Boron Compounds.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Storage and Handling: Section 7

TRI-(DIISOBUTYL CARBINYL) BORATE

Description: White crystals; odor of diisobutyl carbinol.
Formula: $C_{27}H_{57}O_3B$

Constants:
  Mol. Wt. 440.55
  M. P. 99 - 100°C
  B. P. 198 - 209°C @22 mm
Toxicity: See Diisobutylcarbinol and Boron Compounds.
Disaster Control: Slightly dangerous; when heated it emits toxic fumes.
Storage and Handling: Section 7

TRI-n-DODECYL BORATE

Description: Light, straw-yellow, oily liquid.
Formula: $[CH_3(CH_2)_{10}CH_2O]_3B$
Constants:
  Mol. Wt. 566.8
  B. P. 479°C
  Flash P. 465°F (C.O.C.)
  Density 0.845 @26.8°C
  Vap. D. 19.6
Toxicity: See Boron Compounds.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TRIETHANOLAMINE

Description: Pale yellow liquid.
Formula: $(CH_2OHCH_2)_3N$
Constants:
  Mol. Wt. 149.19
  M. P. 21.2°C
  B. P. 360°C
  Flash P. 355°F (C.C.)
  Density 1.1258 @20°/20°C
  Vap. Press. 10 mm @205°C
  Vap. D. 5.14
Toxic Hazard Rating:
  Acute Local: Irritant 1; Ingestion 1; Inhalation 1
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition, it emits toxic fumes of oxides of nitrogen; can react vigorously with oxidizing materials.
Personal Hygiene: Section 3
Storage and Handling: Section 7

TRIETHANOLAMINE BORATE

Description: White odorless solid.
Constants:
  Mol. Wt. 157
  M. P. 235.5 - 238.5°C
Toxicity: See Triethanolamine.
Disaster Control: See Triethanolamine.
Storage and Handling: Section 7

TRIETHANOLAMINE TITANATE

Description: Yellow liquid.
Formula: $Ti[(OCH_2CH_2)NCH_2CH_2OH]_2$
Constants:
  Mol. Wt. 254.14
  Density 1.05
  Vap. D. 8.78
Toxicity: See Esters and Triethanol Amine.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

1,3,3-TRIETHOXYPROPENE-1

Formula: $(C_2H_5O)HCCHCH(C_2H_5O)_2$
Constant:
  Mol. Wt. 174.2
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: U
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

TRIETHYL ALUMINUM. See Aluminum Triethyl.

TRIETHYL AMINE

Description: Colorless liquid.
Formula: $(C_2H_5)_3N$
Constants:
  Mol. Wt. 101.19
  M. P. −114.8°C
  B. P. 89.5°C
  Flash P. 20°F (O.C.)
  Density 0.7229 @25°/4°C
  Vap. D. 3.48
Toxicity: Details unknown. See Amines.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown

Disaster Control: Highly dangerous; keep away from heat or open flame; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

TRIETHYL ARSENIC
Synonym: Arsenic triethyl.
Description: Colorless liquid.
Formula: $As(C_2H_5)_3$
Constants:
Mol. Wt. 162.1
B. P. 140°C @736 mm
Density 1.152
Vap. D. 5.59
Toxicity: Highly toxic. See Arsenic Compounds.
Fire Hazard: Moderate.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of arsenic; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

TRIETHYLBENZENE
Description: Clear, colorless liquid.
Formula: $C_6H_3(CH_2CH_3)_3$
Constants:
Mol. Wt. 162.3
M. P. < -70°C
B. P. 218 - 219°C
Flash P. 181°F
Density 0.870 @25°/25°C
Vap. D. 5.6
Toxicity: Details unknown. See Benzene.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TRIETHYLBISMUTHINE
Synonym: Bismuth triethyl.
Description: Liquid.
Formula: $Bi(C_2H_5)_3$
Constants: Mol. Wt. 296.18
B. P. 107°C @79 mm (can explode)
Density 1.82
Toxicity: See Bismuth Compounds.
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Moderate, when exposed to heat. Explodes @302°F.
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes and explodes; can react with oxidizing materials.
Storage and Handling: Section 7

TRIETHYL BORATE
Description: Colorless liquid, odor of ethyl alcohol.
Formula: $(CH_3CH_2O)_3B$
Constants:
Mol. Wt. 146.0
B. P. 118 - 120°C
Flash P. 90°F (C.O.C.)
Density 0.860 @24°C
Toxicity: See Boron Compounds and Ethyl Alcohol.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated, it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

TRIETHYL CITRATE
Formula: $C_3H_5O(COOC_2H_5)_3$
Constants:
Mol. Wt. 276.3
B. P. 294.0°C
Flash P. 303°F (C.O.C.)
Density 1.136 @25°C
Vap. Press. 1 mm @107.0°C
Toxicity: Probably low. See Citric Acid.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Storage and Handling: Section 7

TRIETHYLENE GLYCOL
Synonyms: 2,2'-Ethylene dioxydiethanol; glycol bis(hydroxyethyl) ether.
Description: Colorless liquid.
Formula: $(CH_2OCH_2CH_2OH)_2$
Constants:
Mol. Wt. 150.17
B. P. 291.2°C
Freezing P. -4.3°C
Flash P. 310°F (O.C.)
Density 1.122 @25°/25°C

Autoign. Temp. 700°F
Vap. Press. 1 mm @114°C
Vap. D. 5.17

Toxicity: A fungicide. See also Glycols.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

Spontaneous Heating: No

To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Moderate, in the form of vapor when exposed to flame.

Explosive Range: 0.89 - 9.20%

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

TRIETHYLENE GLYCOL DIBENZOATE

Description: Crystals.

Formula: $C_6H_5CO_2CH_2CH_2OCH_2CH_2$-$OCH_2CH_2CO_2C_6H_5$

Constants:
Mol. Wt. 358.3
B. P. 210 - 223°C
Freezing P. 46°C
Flash P. 457°F (T.O.C.)
Density 1.168 @25°/4°C

Toxicity: Details unknown. See Glycols.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

TRIETHYLENE GLYCOLDICHLORIDE. See Triglycol Dichloride.

TRIETHYLENE GLYCOL DI-2-ETHYLBUTYRATE

Description: Colorless liquid.

Formula: $C_5H_{11}OCOCH_2(CH_2OCH_2)_2$-$CH_2COOC_5H_{11}$

Constants:
Mol. Wt. 346.45
M. P. -65°C
B. P. 197°C @5 mm
Flash P. 385°F (O.C.)
Density 0.9946 @20°/20°C
Vap. Press. 5.8 mm @200°C
Vap. D. 11.95

Toxicity: Details unknown. See Glycols.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

TRIETHYLENE GLYCOL DI-2-ETHYLHEXOATE

Description: Colorless liquid with mild odor.

Formula: $C_7H_{15}OCOCH_2(CH_2OCH_2)_2$-$CH_2COOC_7H_{15}$

Constants:
Mol. Wt. 402.56
M. P. -58°C
B. P. 218°C @5 mm
Flash P. 405°F
Density 0.9679 @20°/20°C
Vap. Press. 1.9 mm Hg @200°C
Vap. D. 13.9

Toxicity: Details unknown. See Glycols.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

TRIETHYLENE GLYCOL DIMETHYL ETHER

Description: Liquid, water white and mild ethereal odor.

Formula: $CH_3(OCH_2CH_2)_3OCH_3$

Constants:
Mol. Wt. 178.22
B. P. 216°C
Freezing P. -46°C
Flash P. 232°F (O.C.)
Density 0.982 @20°/20°C
Autoign. Temp. 1166°F
Vap. D. 6.14
Vap. Press. 0.9 mm @20°C

Toxicity: See Glycols.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

TRIETHYLENE GLYCOL DIPELARGONATE

Synonym: (TG-9).

Description: Clear liquid; mild characteristic odor.
Formula:
$(CH_2OCH_2)_2(CH_2OCOC_8H_{17})_2$
Constants:
Mol. Wt. 438
Freezing P. −4 to 1°C
Flash P. 420°F
B. P. 251°C @5 mm
Density 0.964 @20°/20°C
Vap. D. 15.1
Toxicity: Details unknown. See Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TRIETHYLENE TETRAMINE

Description: Moderately viscous, yellowish liquid.
Formula:
$H_2NCH_2(CH_2NHCH_2)_2CH_2NH_2$
Constants: Mol. Wt. 146.24
B. P. 278°C
Flash P. 290°F (O.C.)
Density: 0.982
Vap. Press. <0.01 mm @20°C
Autoign. Temp. 640°F
Toxicity: Details unknown. See Amines.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: No
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7
MCA warning label

TRIETHYL-o-FORMATE

Synonyms: Orthoformic ester; triethoxy methane.
Description: Clear liquid, pungent odor.
Formula: $(C_2H_5O)_3CH$
Constants:
Mol. Wt. 148.20
B. P. 145.9°C
Flash P. 86°F
Density 0.895 @20°/20°C
Vap. Press. 10 mm @40.5°C
Vap. D. 5.11
Toxicity: See Formic Acid and Ethyl Alcohol.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Moderately dangerous when exposed to heat or open flame; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

TRI(2-ETHYL HEXYL) BORATE

Description: Colorless, mobile liquid. Odor of 2-ethyl hexanol.
Formula: $[C_4H_9(C_2H_5)CHCH_2O]_3B$
Constants: Mol. Wt. 398.5
B. P. 350 - 354°C
Flash P. 350°F (C.O.C.)
Density 0.857 @23.6°C
Vap. D. 13.8
Toxicity: Details unknown. See Boric Acid and Alcohols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TRI-2-ETHYL-HEXYL PHOSPHATE

Description: Light-colored liquid.
Formula: $(C_2H_5C_6H_{12})_3PO_4$
Constants:
Mol. Wt. 434.6
M. P. −74°C
B. P. 216°C @5 mm
Flash P. 405°F
Density 0.9262 @20°/20°C
Vap. Press. 0.23 mm Hg @150°C
Toxicity: See Phosphoric Acid.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of phosphorus.
Storage and Handling: Section 7

TRIETHYL PHOSPHATE

Description: Liquid.
Formula: $(C_2H_5)_3PO_4$
Constants:
Mol. Wt. 182.2
M. P. −56.5°C
B. P. 209 - 218°C
Flash P. 240°F
Density 1.067 - 1.072 @20°/20°C

Vap. Press. 1 mm @39.6°C
Vap. D. 6.28
Toxicity: See Ethyl Alcohol and Phosphoric Acid.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of phosphorus; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

TRIETHYL PHOSPHINE
Description: Colorless liquid.
Formula: $(C_2H_5)_3P$
Constants:
Mol. Wt. 118.2
B. P. 128°C
Density 0.801 @20°/4°C
Toxicity: Details unknown; probably high.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of phosphorus and phosphine.
Storage and Handling: Section 7

TRIETHYL PHOSPHINE OXIDE
Description: Colorless, deliquescent crystals.
Formula: $(C_2H_5)_3PO$
Constants:
Mol. Wt. 134.2
M. P. 52.9°C
B. P. 242.9°C
Toxicity: Details unknown; probably high.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of phosphorus compounds.
Storage and Handling: Section 7

TRIETHYL PHOSPHINE SULFIDE
Description: Crystals.
Formula: $(C_2H_5)_3PS$
Constants:
Mol. Wt. 150.2
M. P. 94°C
B. P. Ignites.
Toxicity: Details unknown; probably high.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of phosphorus and sulfur; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

TRIETHYL PHOSPHOROTHIOATE
Description: Colorless liquid; strong characteristic odor.
Formula: $(C_2H_5O)_3PS$
Constants: Mol. Wt. 198.2
B. P. 93.5 - 94°C @10 mm
Flash P. 225°F (C.O.C.)
Density 1.074 @20°/4°C
Toxicity: Details unknown; probably moderate.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

TRIETHYL STIBINE
Synonym: Antimony triethyl.
Description: Liquid.
Formula $(C_2H_5)_3Sb$
Constants: Mol. Wt. 208.9
M. P. < -29°C
B. P. 159.5°C
Density 1.324 @16°C
Toxicity: See Antimony Compounds.
Fire Hazard: Dangerous, by chemical reaction with oxidizers. Spontaneously flammable liquid.
Disaster Control: Dangerous; shock can shatter the container; when heated to decomposition it emits highly toxic fumes of antimony and on contact with oxidizing materials, it can react vigorously.
Storage and Handling: Section 7

TRI-(1-ETHYNYLCYCLOHEXYL) BORATE
Description: Pale-yellow liquid; odor of 1-ethynyl cyclohexanol.
Constants: Mol. Wt. 380.34
B. P. 150 - 170°C @0.5 mm
Flash P. 190°F (C.O.C.)
Density 1.006 @27°C
Toxicity: See Boron Compounds and Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam,

carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TRIFLUOROACETIC ACID
Description: Colorless liquid; strong pungent odor.
Formula: CF_3COOH
Constants:
Mol. Wt. 114
M. P. -15.25°C
B. P. 71.1°C @734 mm
Density 1.535 @0°C
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

TRIFLUOROCHLOROETHYLENE
Synonym: Monochlorotrifluoroethylene.
Description: Colorless gas.
Formula: C_2F_3Cl
Constants: Mol. Wt. 116.48
M. P. -157.5°C
B. P. -27.9°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Inhalation 1
Chronic Local: U
Chronic Systemic: U
Caution: An asphyxiant
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of fluorides and chlorides.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable gas; red gas label.
Coast Guard Classification: Noninflammable gas; green gas label.

TRIFLUOROMETHYLBENZENE.
See Benzotrifluoride.

TRIFLUORONITROSOMETHANE
Description: Bright blue gas.
Formula: CF_3NO
Constants:
Mol. Wt. 99.02
M. P. -150°C
B. P. -80°C
Toxic Hazard Rating:
Acute Local: Irritant 3; Inhalation 3
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Caution: A military poison.
Disaster Control: Dangerous; shock can shatter the compressed gas container with explosive force; when heated to decomposition it emits highly toxic fumes of fluorides and oxides of nitrogen.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

TRIFLUOROPENTACHLOROPROPANE
Description: Liquid.
Formula: $C_3F_3Cl_5$
Constants: Mol. Wt. 270.3
B. P. 155°C
Flash P. 228°F
Toxicity: See Halogenated Hydrocarbons, Aliphatic.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of fluorides and chlorides; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

TRIFLUOROTRICHLOROETHANE
Description: Colorless gas.
Formula: CCl_3CF_3
Constants:
Mol. Wt. 187.39
M. P. 13.2°C
B. P. 45.8°C
Density 1.5702
Auotign. Temp. 1256°F
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Inhalation 1
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Very slight; when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition it may emit highly toxic fumes of fluorides and chlorides.
Storage and Handling: Section 7

TRIGERMANE
Synonym: Germanium hydride.
Description: Colorless liquid.
Formula: Ge_3H_8
Constants:
Mol. Wt. 225.86
M. P. −105.6°C
B. P. 110.5°C
Density 2.2
Toxicity: Details unknown. See also Hydrides and Germanium Compounds.
Fire Hazard: Moderate. See also Hydrides.
Explosion Hazard: Details unknown. See also Hydrides.
Disaster Control: See Hydrides.
Storage and Handling: Section 7

TRIGLYCOL DICHLORIDE
Description: Colorless liquid.
Formula: $Cl(C_2H_4O)_2C_2H_4Cl$
Constants: Mol. Wt. 187.09
B. P. 240°C
Freezing P. −31.5°C
Flash P. 250°F (O. C.)
Density 1.197
Vap. Press. 0.03 mm @20°C
Toxicity: Details unknown. See also Glycols.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides; can react with oxidizing materials.
Storage and Handling: Section 7

TRI-n-HEXYL BORATE
Description: Colorless liquid; odor of n-hexanol.
Formula: $[CH_3(CH_2)_5O]_3B$
Constants:
Mol. Wt. 314.3
B. P. 140 - 146°C @2 mm
Flash P. 300°F
Density 0.847 @28°C
Vap. D. 10.8
Toxicity: See n-Hexyl Alcohol and Boron Compounds.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TRIHEXYLENE GLYCOL BIBORATE
Description: Colorless liquid; odor of hexylene glycol.
Formula: $C_{18}H_{36}O_6B_2$
Constants:
Mol. Wt. 370.1
B. P. 143 - 149°C @2 mm
Flash P. 345°F
Density 0.982 @21°C
Vap. D. 12.8
Toxicity: See Boron Compounds and Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TRI-IRON PHOSPHIDE
Description: Gray crystals.
Formula: Fe_3P
Constants:
Mol. Wt. 198.53
M. P. 1100°C
Density 6.74
Toxicity: See Phosphides.
Fire Hazard: See Phosphides.
Explosion Hazard: See Phosphides.
Disaster Control: See Phosphides.
Storage and Handling: Section 7

TRIISOBUTYL BORATE
Description: Colorless liquid; odor of isobutyl alcohol.
Formula: $[CH_3CH(CH_3)CH_2O]_3B$
Constants:
Mol. Wt. 230.16
B. P. 212°C
Flash P. 185°F (C.O.C.)
Density 0.843 @23°C
Toxicity: See Boron Compounds and Isobutanol.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

O,O,O-TRIISOOCTYL PHOSPHOROTHIOATE
Description: Colorless liquid;

mild characteristic odor.
Formula: $(C_8H_{17}O)_3PS$
Constants:
Mol. Wt. 450.7
B. P. 160 - 170°C @0.2 mm
Flash P. 410°F (C.O.C.)
Density 0.933 @20°/4°C
Toxicity: Details unknown; probably slight.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

TRIISOPROPANOLAMINE

Description: Crystalline, pure white solid.
Formula: $N(C_3H_6OH)_3$
Constants:
Mol. Wt. 191.27
M. P. 45°C
B. P. 305°C
Flash P. 580°F (O.C.)
Density 1.0200 @20°/20°C
Vap. Press. <0.01 mm @20°C
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

TRIISOPROPYL BENZENE

Description: Clear, colorless liquid.
Formula: $C_6H_3[CH(CH_3)_2]_3$
Constants:
Mol. Wt. 204.3
M. P. -15°C
B. P. 236 - 237°C
Flash P. 205°F
Density 0.854 @25°/25°C
Vap. D. 7.0
Toxicity: Details unknown. See Benzene.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

TRIISOPROPYL BORATE

Description: Colorless liquid.
Formula: $(C_9H_{21}O_3)B$
Constants:
Mol. Wt. 188.08
M. P. -59°C
B. P. 141.0 - 142.4°C
Flash P. 82°F (T.C.C.)
Density 0.8138 @25°C
Toxicity: Moderate. See Isopropanol and Boron Compounds.
Fire Hazard: Dangerous; when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous. Keep away from flame and heat; can react vigorously with oxidizing material.
Storage and Handling: Section 7

TRIMANGANESE DIPHOSPHIDE

Description: Dark gray crystals.
Formula: Mn_3P_2
Constants:
Mol. Wt. 226.75
M. P. 1095°C
Density 5.12 @18°C
Toxicity: See Phosphides and Manganese Compounds.
Fire Hazard: See Phosphides.
Explosion Hazard: See Phosphides.
Disaster Control: See Phosphides.
Storage and Handling: Section 7

TRIMETHYL ADIPIC ACID

Description: Powder.
Formula: $C_9H_{16}O_4$
Constant:
Mol. Wt. 188.2
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Slightly

dangerous; when heated it emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

TRIMETHYLAMINE

Description: Colorless gas.
Formula: $(CH_3)_3N$
Constants:
  Mol. Wt. 59.11
  B. P. 2.87°C
  Freezing P. −117.1°C
  Density 0.662 @−5°C
  Autoign. Temp. 374°F
Toxic Hazard Rating:
  Acute Local: Inhalation 2
  Acute Systemic: Inhalation 2
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to flame (Section 6).
Explosion Hazard: Moderate, when exposed to spark or flame.
Explosive Limits: 2.0 - 11.60%.
Disaster Control: Moderately dangerous; when heated, it emits toxic fumes; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I.C.C. Classification: Anhydrous: Flammable gas; red gas label.
  Coast Guard Classification: Anhydrous: Inflammable gas; red gas label.
  MCA warning label

TRIMETHYLAMINE, AQUEOUS SOLUTION. See Trimethylamine.
Shipping Regulations: Section 11.
  I.C.C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Inflammable liquid; red label.

TRI(METHYL AMYL) BORATE

Synonym: Tri(methyl isobutylcarbinyl) borate.
Description: Colorless, mobile liquid; characteristic odor.
Formula: $[(CH_3)_2CHCH_2CHOCH_3]_3B$
Constants:
  Mol. Wt. 314.3
  B. P. 257°C
  Flash P. 220°F (C.O.C.)
  Density 0.819 @29°C
  Vap. D. 10.8
Toxicity: See Boric Acid and Alcohols.
Fire Hazard: Slight when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes; on contact with oxidizing materials, it can react vigorously.
Storage and Handling: Section 7

TRIMETHYL ARSENIC

Synonym: Arsenic trimethyl.
Description: Colorless liquid.
Formula: $As(CH_3)_3$
Constants:
  Mol. Wt. 120.0
  B. P. 70°C
  Density 1.124
  Vap. D. 4.14
Toxicity: Highly toxic. See Arsenic Compounds.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of arsenic; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

TRIMETHYLBISMUTHINE

Synonym: Bismuth trimethyl.
Description: Liquid.
Formula: $Bi(CH_3)_3$
Constants:
  Mol. Wt. 254.10
  B. P. 110°C
  Density 2.300 @18°C
Toxicity: See Bismuth Compounds.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes of bismuth; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

TRIMETHYL BORATE

Description: Colorless liquid.

Formula: $(CH_3O)_3B$
Constants:
  Mol. Wt. 103.92
  B. P. 65°C
  Density 0.92 @20°C
Toxicity: Details unknown. See also Boron Compounds
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: See Methanol.
Disaster Control: Dangerous. Upon exposure to heat, it emits toxic fumes; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

3,3,5-TRIMETHYL CYCLOHEXANOL-1

Synonym: Trimethyl cyclohexanol.
Description: Liquid.
Formula: $C_9H_{18}O$
Constants:
  Mol. Wt. 142.23
  Freezing P. 37.0°C
  B. P. 198°C
  Flash P. 165°F (O.C.)
  Density 0.878 @40°/20°C
  Vap. Press. 0.1 mm @20°C
  Vap. D. 4.91
Toxic Hazard Rating:
  Acute Local: Irritant 2
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated, it emits toxic fumes; can react with oxidizing materials.
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
MCA warning label.

TRIMETHYL CYCLOHEXANONE

Description: Liquid.
Formula: $C_9H_{16}O$
Constant:
  Mol. Wt. 140.2
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: U
  Chronic Local: U
  Chronic Systyemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

TRIMETHYL DEHYDROQUINOLINE POLYMER

Description: Amber pellets.
Formula: $(C_{12}H_{15}N)_3$(approx.)
Constants:
  Mol. Wt. 519.93 (approx.)
  M. P. Softens @75°C
  Density 1.08
Toxicity: Details unknown; probably moderate.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of cyanides.
Storage and Handling: Section 7

TRIMETHYLENE BROMIDE

Description: Colorless liquid.
Formula: $C_3H_6Br_2$
Constants:
  Mol. Wt. 201.9
  B. P. 166.5°C
  Freezing P. −33°C
  Density 1.977 @25°/25°C
  Vap. D. 7.0
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of bromine.
Storage and Handling: Section 7

TRIMETHYLENE CHLOROBROMIDE

Description: Colorless liquid.
Formula: C_3H_6ClBr
Constants:
  Mol. Wt. 157.5
  B. P. 143 - 145°C
  Flash P. None
  Density 1.594 @25°/25°C
  Vap. D. 5.5
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of halogens.
Storage and Handling: Section 7

TRIMETHYLENE GLYCOL DINITRATE

Toxicity: Details unknown. See Nitrates.
Fire Hazard: See Nitrates.

Explosion Hazard: See Nitrates.
Explosive Range: @225°F.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

TRIMETHYLENE TRINITRAMINE

Synonyms: Cyclonite; hexogen.
Description: Solid.
Toxicity: Details unknown. See Nitrates.
Fire Hazard: See Nitrates.
Explosion Hazard: Severe, when shocked or exposed to heat. It is one of the most powerful high explosives in use today; has more shattering power than TNT. It is used, mixed with TNT, as a bursting charge for aerial bombs, mines and torpedoes, and it can also be used as a booster because it is easily initiated by mercury fulminate.
Disaster Control: See Nitrates and Explosives, High.
Storage and Handling: Section 7

TRIMETHYL o-FORMATE

Description: Colorless liquid; pungent odor.
Formula: $HC(OCH_3)_3$
Constants:
Mol. Wt. 106.12
Vap. D. 3.67
Toxicity: Details unknown; probably slight.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

2, 2, 5-TRIMETHYLHEXANE

Description: A clear liquid.
Formula: C_9H_{26}
Constants:
Mol. Wt. 134.3
B. P. 125°C
Freezing P. −106°C
Flash P. 55°F
Density 0.707 @20°/4°C
Vap. Press. 12.9 mm @21°C
Vap. D. 4.7
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Highly dangerous; keep away from heat or open flame; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

2, 3, 3-TRIMETHYLHEXANE

Description: Colorless liquid.
Formula: C_9H_{20}
Constants:
Mol. Wt. 128.25
B. P. 137.7°C
Freezing P. −116.8°C
Flash P. 79°F
Density 0.734 @25°/4°C
Vap. Press. 10.1 mm @25°C
Vap. D. 4.43
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; keep away from heat or open flame; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

2, 3, 4-TRIMETHYLHEXANE

Description: Colorless liquid.
Formula: C_9H_{20}
Constants:
Mol. Wt. 128.25
B. P. 139°C
Flash P. 80.8°F
Density 0.737 @25°/4°C
Vap. Press. 9.1 mm @25°C
Vap. D. 4.43
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous. Keep away from heat or open flame. It can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

3, 3, 4-TRIMETHYLHEXANE

Description: Colorless liquid.
Formula: C_9H_{20}
Constants:
Mol. Wt. 128.25

B. P. 140.5°C
Freezing P. −101.2°C
Flash P. 79°F
Density 0.741 @25°/4°C
Vap. Press. 8.6 mm @25°C
Vap. D. 4.43
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous. Keep away from heat or open flame; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

3,5,5-TRIMETHYLHEXANOL
Description: Colorless liquid.
Formula: $CH_3C(CH_3)_2CH_2CHCH_3CH_2CH_2OH$
Constants:
Mol. Wt. 144.25
M. P. −70°C
B. P. 195°C
Flash P. 200°F (O.C.)
Density 0.824 @25°/4°C
Vap. D. 5.0
Toxicity: See Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TRI-(METHYLISOBUTYL CARBINYL) BORATE
Description: Colorless liquid.
Formula: $[CH_3CH(CH_3)CH_2CHO(CH_3)]_3B$
Constants:
Mol. Wt. 314.31
B. P. 257 - 262°C
Flash P. 230°F (C.O.C.)
Density 0.823 @24.8°C
Toxicity: Details unknown. See Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

2,6,8-TRIMETHYL NONANONE-4
Description: Liquid.
Formula: $C_{12}H_{24}O$
Constants:
Mol. Wt. 184.2
M. P. −75°C
B. P. 211 - 219°C
Flash P. 195°F (O.C.)
Density 0.8165 @20°/20°C
Vap. D. 6.37
Toxicity: Details unknown. See Ketones.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TRIMETHYL NONYL ALCOHOL
Description: Liquid.
Formula: $CH_3CH(CH_3)CH_2CH(OH)$-$CH_2CH(CH_3)CH_2CH(CH_3)CH_3$
Constants:
Mol. Wt. 186.33
B. P. 225.2°C
Freezing P. −60°C
Flash P. 200°F (O.C.)
Vap. Press. <0.01 mm @20°C
Density 0.8193 @20°/20°C
Vap. D. 6.43
Toxicity: See Alcohols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TRIMETHYLOLETHANE
Synonyms: 2,2-dimethylol propanol-1.
Description: White, odorless, crystalline powder.
Formula: $CH_3C(CH_2OH)_3$
Constants:
Mol. Wt. 120.15
M. P. About 200°C
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat (Section 6).
Storage and Handling: Section 7

2,2,4-TRIMETHYL-1,3-PENTANEDIOL
Description: White, crystalline solid.
Formula: $C_8H_{18}O_2$

Constants:
Mol. Wt. 146.2
M. P. 49 to 51°C
B. P. 109 to 111°C @4 mm
Toxicity: Details unknown; an insect repellent.
Fire Hazard: Slight; when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

2,4,4-TRIMETHYL PENTENE-1

Description: A clear liquid.
Formula: C_8H_{16}
Constants:
Mol. Wt. 112.2
B. P. 101.3°C
Freezing P. −94°C
Flash P. < 20°F
Density 0.719 @15.5°/15.5°C
Vap. Press. 801 mm @38°C
Vap. D. 3.9
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Highly dangerous. Keep away from heat or open flame; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

2,4,4-TRIMETHYLPENTENE-2

Description: A clear liquid.
Formula: C_8H_{16}
Constants: Mol. Wt. 112.2
B. P. 104.5°C
Flash P. 35°F (T.O.C.)
Freezing P. −106.4°C
Density 0.724 @15.5°/15.5°C
Vap. Press. 77.5 mm @38°C
Vap. D. 3.9
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fires: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Highly dangerous. Keep away from heat or open flame; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

TRIMETHYL PHOSPHINE

Description: Colorless liquid.
Formula: $(CH_3)_3P$
Constants:
Mol. Wt. 76.1
B. P. 42°C
Density < 1
Toxicity: Details unknown; probably high. See also Phosphine.
Fire Hazard: Moderate, when exposed to heat or flame or by chemical reaction. See also Phosphine.
Explosion Hazard: Slight, when exposed to flame.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of phosphorus oxides; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

TRIMETHYL STIBINE

Description: Liquid.
Formula: $(CH_3)_3Sb$
Constants: Mol. Wt. 166.9
B. P. 80.6°C
Density 1.523 @15°C
Toxicity: See Antimony Compounds.
Fire Hazard: Dangerous, by chemical reaction. A spontaneously flammable liquid (Section 6).
Explosion Hazard: Slight, in the form of vapor when exposed to flame.
Disaster Control: See Antimony Compounds.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

2,4,6-TRIMETHYL-1,2,3,6-TETRAHYDROBENZALDEHYDE

Description: Liquid.
Formula: $CH(CH_3)CHC(CH_3)CH_2$-$CH(CH_3)CHCHO$
Constants:
Mol. Wt. 152.23
M. P. −41.9°C
B. P. 204.5°C
Flash P. 185°F (O.C.)
Density 0.9195 @20°/20°C
Vap. Press. 0.3 mm @20°C
Vap. D. 5.25

Toxicity: Details unknown. See Aldehydes.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TRINICKEL DIPHOSPHIDE
Description: Dark green-black crystals.
Formula: Ni_3P_2
Constants:
Mol. Wt. 238.03
Density 5.99
Toxicity: See Phosphides and Nickel Compounds.
Fire Hazard: See Phosphides.
Explosion Hazard: See Phosphides.
Disaster Control: See Phosphides.
Storage and Handling: Section 7

TRINITROACETONITRILE
Description: Solid.
Formula: $C_2N_4O_6$
Constant: Mol. Wt. 176.05
Toxicity: See Cyanides.
Explosion Hazard: Moderate, when exposed to heat.
Explosive Range: @392°F.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of cyanides and explodes; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

TRINITROANILINE
Synonym: Picramide.
Description: Crystals.
Formula: $C_6H_4N_4O_6$
Constants: Mol. Wt. 228.1
M. P. 188°C
B. P. Explodes
Density 1.762
Toxicity: See Nitrates and Aniline.
Fire Hazard: See Nitrates.
Explosion Hazard: Severe, when shocked or exposed to heat. A very sensitive high explosive.
Disaster Control: Highly dangerous; shock will explode it; when heated to decomposition it emits highly toxic fumes of oxides of nitrogen and explodes; can react vigorously with reducing materials.
Storage and Handling: Section 7

TRINITROANISOL
Synonym: Methyl picrate.
Description: Crystals.
Formula: $CH_3OC_6H_2(NO_2)_3$
Constants: Mol. Wt. 243.13
M. P. 68.4°C
Density 1.408 @20°/4°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 1
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: Allergen 1
Chronic Systemic: Ingestion 2; Inhalation 2; Skin Absorption 2
Fire Hazard: See Nitrates.
Explosion Hazard: Severe, when shocked or exposed to heat. Trinitroanisol resembles picric acid in its high explosive properties but does not attack metals provided it is protected from moisture. It has a lower melting point than picric acid which is an advantage in shell loading. It is used as a booster charge.
Disaster Control: Highly dangerous; shock will explode it; when heated to decomposition it emits highly toxic fumes of oxides of nitrogen and explodes; can react vigorously with reducing materials.
Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

TRINITROBENZALDEHYDE
Description: Liquid.
Formula: $C_6H_2CHO(NO_2)_3$
Constants: Mol. Wt. 241.1
M. P. 119°C
Toxicity: See Aldehydes and Nitrates.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of nitrogen and explodes; can react vigorously with reducing materials.
Storage and Handling: Section 7

1,3,5-TRINITROBENZENE
Description: Yellow crystals.
Formula: $C_6H_3(NO_2)_3$

Constants: Mol. Wt. 213.11
M. P. 122°C
B. P. Decomposes
Density 1.688 @20°/4°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 3; Inhalation 3
Chronic Local: U
Chronic Systemic: Ingestion 3; Inhalation 3
Fire Hazard: See Nitrates.
Explosion Hazard: Severe, when shocked or exposed to heat. Trinitrobenzene is considered a powerful high explosive and has more shattering power than TNT. It is less sensitive to impact than TNT. However, it is not used much because it is difficult to produce.
Disaster Control: Highly dangerous; shock will explode it; when heated to decomposition it emits highly toxic fumes of oxides of nitrogen and explodes; can react vigorously with reducing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
First Aid: Section 1
Storage and Handling: Section 7

TRINITROBENZENE, WET(NOT TO EXCEED 16 OZ.) See 1,3,5-Trinitrobenzene.
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable solid.
Coast Guard Classification: Inflammable solid; yellow label.

TRINITROCHLORBENZENE
Description: Solid.
Formula: $C_6H_2Cl(NO_3)_3$
Constant:
Mol. Wt. 295.6
Toxicity: See Nitro Compounds of Aromatic Hydrocarbons.
Fire Hazard: See Nitrates.
Explosion Hazard: Severe when shocked or exposed to heat.
Disaster Control: Highly dangerous; shock will explode it; when heated to decomposition it emits highly toxic fumes of phosgene and oxides of nitrogen and explodes; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

2,4,6-TRINITRO-m-CRESOL
Synonym: Cresolite.
Description: Yellow crystals.
Formula: $(NO_2)_3C_6H(CH_3)OH$
Constants:
Mol. Wt. 243.13
M. P. 106°C
B. P. Explodes @150°C
Toxicity: See Nitro Compounds of Armoatic Hydrocarbons.
Fire Hazard: See Nitrates.
Explosion Hazard: Severe, when shocked or exposed to heat. Trinitrocresol is not as powerful a high explosive as TNT or picric acid. It has been used as a bursting charge and in combination with other high explosives.
Disaster Control: Highly dangerous; shock will explode it; when heated to decomposition it emits highly toxic fumes of oxides of nitrogen and explodes; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

2,4,4'-TRINITRODIPHENYLAMINE
Description: Crystals.
Formula: $C_6H_3(NO_2)_2NHC_6H_4NO_2$
Constant:
Mol. Wt. 304.2
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

TRINITROPHENOL. See Picric Acid.

TRINITROPHENYLMETHYLNITRAMINE. See Tetryl.

TRINITROPHENYLNITRAMINE ETHYL NITRATE
Synonym: Petryl.
Toxicity: Unknown
Fire Hazard: See Nitrates.

Explosion Hazard: Severe when shocked or exposed to heat. Explodes when heated; is soluble in nitroglycerin. Its high explosive sensitivity to impact and friction are about the same as that of tetryl, but its shattering power is much greater. It is used as a basecharge in detonators.
Disaster Control: Extremely dangerous; shock will explode it; when heated to decomposition it emits highly toxic fumes of oxides of nitrogen and explodes; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

TRINITROPHLOROGLUCIN
Synonym: Trinitrophloroglucinol.
Description: Powder.
Formula: $C_6(NO_2)_3(OH)_3$
Constant:
Mol. Wt. 261.1
Toxicity: Details unknown. See Nitrates.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: Dangerous; shock will explode it; when heated to decomposition it emits highly toxic fumes of oxides of nitrogen and explodes; can react vigorously with oxidizing or reducing materials.
Storage and Handling: Section 7

TRINITRORESORCINOL. See Styphnic Acid.

TRINITROTOLUENE
Synonyms: TNT; sym-trinitrotoluol; triton.
Description: Colorless, monoclinic crystals.
Formula: $(NO_2)_3C_6H_2CH_3$
Constants:
Mol. Wt. 227.13
M. P. 80.7 °C
B. P. 240 °C Explodes
Flash P. Explodes
Density 1.654
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 2
Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 2
Chronic Local: Irritant 2; Allergen 2
Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
MAC: ACGIH (accepted); 0.5 milligrams per cubic meter of air.
Fire Hazard: See Nitrates.
Explosion Hazard: Moderate; will detonate under strong shock. See Explosive, High. It detonates at around 240 °C but can be distilled safely under reduced pressure. It is a comparatively insensitive explosive. In small quantities it will burn quietly if not confined. However, sudden heating of any quantity will cause it to detonate; the accumulation of heat when large quantities are burning will cause detonation. In other respects it is one of the most stable of all high explosives and there are but few restrictions to its handling. It is for this reason, from the military standpoint, that TNT is quantitatively the most used. It requires a fall of 130 centimeters for a 2 kilogram weight to detonate it. It is one of the most powerful high explosives. It can be detonated by the usual detonators and blasting caps (at least a No. 6). For full efficiency, the use of a high velocity initiator, such as tetryl is required. TNT is one of those explosives containing an oxygen deficiency. In other words, the addition of products which are oxygen rich can enhance its explosive power. Also mono- and dinitrotoluene may be added for reduction of the temperature of the explosion and to make the explosion flashless. Various materials are added to TNT to make what is known as permissible explosives. TNT may be regarded as the equivalent of 40 percent dynamite and can be used under water. It is also used in the manufacture of detonator fuse known as Cordeau Detonant. For the military, TNT finds use in all types of bursting charges, including armor-piercing types, although it is somewhat too sensitive to be ideal for this purpose, and has since been replaced to a great extent by ammonium picrate. It is a relatively expensive explosive and does not compete

seriously with dynamite for general commercial use.

Disaster Control: Highly dangerous; shock will explode it; when heated to decomposition it emits highly toxic fumes of oxides of nitrogen; can react vigorously with reducing material.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

TRINITROTOLUENE, WET (NOT TO EXCEED 16 OZ.). See Trinitrotoluene.

Shipping Regulations: Section 11

I. C. C. Classification: Flammable solid.

Coast Guard Classification: Inflammable solid; yellow label.

2, 4, 6-**TRINITROXYLENE**

Synonym: TNX.

Description: Rhombic crystals.

Formula: $(NO_2)_3C_6H(CH_3)_2$

Constants:

Mol. Wt. 241.16

M. P. 181.5°C

Density 1.604 @19°C

Toxicity: Unknown

Fire Hazard: See Nitrates.

Explosion Hazard: Severe, when shocked or exposed to heat. This high explosive is not very powerful when used alone. However, the addition of picric acid or other nitro-type of high explosive serves to lower its melting point and to reinforce its explosive power. Is also used in mixtures with ammonium nitrate; in detonating compositions, and mixed with other high explosives, as a bursting charge.

Disaster Control: Highly dangerous; shock will explode it; when heated to decomposition it emits highly toxic fumes of oxides of nitrogen and explodes; can react vigorously with oxidizing materials.

Storage and Handling: Section 7

TRI-2-OCTYLBORATE

Description: Colorless liquid; odor of 2-octanol.

Formula: $[CH_3(CH_2)_5C(CH_3)HO]_3B$

Constants:

Mol. Wt. 398.47

B. P. 340 - 349°C

Flash P. 330°F (C. O. C.)

Density 0.837 @24.5°C

Vap. D. 13.8

Toxicity: See Boric Acid and 2-Octanol.

Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

TRI-n-OCTYLBORATE

Description: Colorless liquid; odor of octyl alcohol.

Formula: $[CH_3(CH_2)_7O]_3B$

Constants:

Mol. Wt. 398.5

B. P. 192 - 194°C @2 mm

Flash P. 370°F (C. O. C.)

Density 0.846 @23°C

Vap. D. 13.7

Toxicity: See Octyl Alcohol and Boron Compounds.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

TRIOCTYL PHOSPHATE

Description: Liquid.

Formula: $[C_4H_9CH(C_2H_5)CH_2O]_3P{:}O$

Constants:

Mol. Wt. 434.63

M. P. -74°C

B. P. 216°C @5 mm

Flash P. 405°F (O. C.)

Density 0.9262 @20°/20°C

Vap. D. 14.95

Toxicity: Details unknown. See Esters.

Fire Hazard: Slight, when exposed to heat or flame.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of phosphorus; can react with oxidizing materials.

Storage and Handling: Section 7

TRIOL - 230
Description: Clear, colorless liquid.
Formula: $HOCH_2CH_2OCH_2(CH_3)$-$(CH_2OH)CCH_2(CH_3)CHCH_2OH$
Constants:
Mol. Wt. 206.28
B. P. 196°C at 5 mm
Flash P. 395°F (C. O. C.)
Freezing P. < -5°C
Density 1.081 @20°/20°C
Vap. Press. < 0.01 mm at 20°C
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TRIOLEYL BORATE
Description: Pale yellow liquid; odor of oleyl alcohol.
Formula:
$[CH_3(CH_2)_7CHCH(CH_2)_7CH_2O]_3B$
Constants:
Mol. Wt. 813.20
B. P. 300 -330°C @0.5 mm
Flash P. 495°F (C. O. C.)
Density 0.860 @23.6°C
Toxicity: See Boron Compounds and Oleyl Alcohol.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical, or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TRIOXANE
Synonym: α-Trioxymethylene.
Description: Colorless crystals; odor of ether-alcohol.
Formula: $(CH_2O)_3$
Constants:
Mol. Wt. 90.08
M. P. 62°C
B. P. 114.5°C sublimes
Flash P. 113°F (C. C.)
Density 1.17 @65°/20°C
Autoign. Temp. 777°F
Vap. Press. 13 mm @25°C
Vap. D. 3.1
Toxicity: Details unknown. Can evolve formaldehyde when heated strongly or in contact with strong acids. See also Formaldehyde.
Fire Hazard: Moderate fire hazard when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, in the form of vapor when exposed to flame.
Explosive Range: 3.57 - 28.7%.
Disaster Control: Moderately dangerous; can explode when heated; reacts with oxidizing materials; and on contact with acid or acid fumes, it can emit toxic fumes.
Storage and Handling: Section 7

TRIOXIME
Toxicity: Unknown
Fire Hazard: Unknown
Explosion Hazard: Moderate, when exposed to heat.
Explosive Range: @311°F.
Storage and Handling: Section 7

TRIPENTAERYTHRITOL
Description: White to ivory, odorless powder.
Formula: $C_{15}H_{32}O_{10}$
Constants:
Mol. Wt. 372.4
M. P. Approx. 240°C
Density 1.30
Toxicity: See Alcohols.
Fire Hazard: Slight; when heated it emits smoke (Section 6).
Storage and Handling: Section 7

TRIPHENYLARSENIC
Synonym: Arsenic triphenyl.
Description: White crystals.
Formula: $As(C_6H_5)_3$
Constants: Mol. Wt. 306.2
M. P. 60°C
Density 1.2225 @48°C
B. P. >360°C (in CO_2)
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

TRIPHENYLBISMUTHINE
Synonym: Bismuth triphenyl.
Description: Monoclinic crystals.
Formula: $Bi(C_6H_5)_3$
Constants: Mol. Wt. 440.30
M. P. 78°C
B. P. 242°C @14 mm
Density 1.585
Toxicity: Highly toxic. See Phenol and Bismuth Compounds.

Fire Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes it emits highly toxic fumes.
Storage and Handling: Section 7

TRIPHENYL BORATE
Description: White to pink solid; odor of phenol.
Formula: $(C_6H_5O)_3B$
Constants:
Mol. Wt. 290.12
M. P. 65 - 85°C
B. P. 360 - 370°C
Toxicity: Highly toxic. See Phenol and Boron Compounds.
Fire Hazard: Moderate, when exposed to heat or flame. Hydrolyzes to phenol.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated it emits highly toxic fumes; reacts with water or steam to form toxic fumes of phenol; in contact with oxidizing material, it can react vigorously.
Storage and Handling: Section 7

TRIPHENYL-3,4-DICHLOROPHENYL PHOSPHONIUM CHLORIDE
Description: A solid.
Formula: $(C_6H_5)_3(C_6H_3Cl_2)PCl$
Constant:
Mol. Wt. 443.7
Toxicity: Details unknown; a moth repellent.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides and oxides of phosphorus.
Storage and Handling: Section 7

TRIPHENYLMETHANE DYES
Synonym: Rosaniline dyes.
Toxicity: Details unknown; fungicides.
Disaster Control: Moderately dangerous; when heated they emit toxic fumes.
Storage and Handling: Section 7

TRIPHENYL PHOSPHATE
Description: Colorless, odorless, crystalline solid.
Formula: $PO(OC_6H_5)_3$
Constants:
Mol. Wt. 326.28
M. P. 48.5°C
B. P. 245°C @11 mm
Flash P. 428°F (C.C.)
Density 1.268 @60°C
Vap. Press. 1 mm @193.5°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Water, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of phosphorus.
Personal Hygiene: Section 3
Storage and Handling: Section 7

TRIPHENYL PHOSPHINE
Description: Crystals.
Formula: $(C_6H_5)_3P$
Constants:
Mol. Wt. 262.3
M. P. 79°C
B. P. > 360°C
Density 1.194
Toxicity: Probably highly toxic. See Phosphine.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: Slight, in the form of vapor when exposed to flame.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of phosphine and oxides of phosphorus; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

TRIPHENYL PHOSPHINE OXIDE
Description: White crystals.
Formula: $(C_6H_5)_3PO$
Constants:
Mol. Wt. 278.3
M. P. 156°C
B. P. > 360°C
Density 1.2124 @22.6°C
Toxicity: Probably highly toxic. See Phosphine.

Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of phosphorus.
Storage and Handling: Section 7

TRIPHENYL STIBINE
Description: Crystals.
Formula: $(C_6H_5)_3Sb$
Constants:
Mol. Wt. 353.1
M. P. 54°C
Toxicity: See Antimony Compounds.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of antimony; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

TRIPROPYLAMINE
Description: Liquid.
Formula: $N(C_3H_7)_3$
Constants: Mol. Wt. 143.3
M. P. -93.5°C
B. P. 156°C
Flash P. 105°F
Density 0.75
Toxicity: See Amines.
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

TRI-n-PROPYL BORATE
Description: Colorless liquid; odor of n-propanol.
Formula: $(CH_3CH_2CH_2O)_3B$
Constants:
Mol. Wt. 188.08
B. P. 176 - 179°C
Flash P. 155°F (C.O.C.)
Density 0.856 @24°C
Toxicity: See n-Propanol and Boron Compounds.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Storage and Handling: Section 7

TRIPROPYLENE GLYCOL
Description: Colorless liquid.
Formula: $HOC_3H_6OC_3H_6OC_3H_6OH$
Constants:
Mol. Wt. 192.3
M. P. Does not crystallize
B. P. 267°C
Flash P. 285°F
Density 1.023 @25°/25°C
Vap. Press. 1 mm @96.0°C
Vap. D. 6.63
Toxicity: See Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TRIPROPYLENE GLYCOL METHYL ETHER
Description: Colorless liquid.
Formula:
$CH_3OC_3H_6OC_3H_6OC_3H_6OH$
Constants:
Mol. Wt. 206.3
B. P. 243°C
Flash P. 250°F
Density 0.967 @25°/25°C
Vap. D. 7.1
Toxicity: See Glycols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TRIPROPYLENE GLYCOL MONOMETHYL ETHER
Description: Liquid.
Formula: $CH_3OC_3H_6OC_3H_6OC_3H_6OH$
Constants:
Mol. Wt. 206.3
M. P. Does not crystallize
B. P. 243°C
Flash P. 250°F
Density 0.967 @25°/25°C
Vap. D. 7.12
Toxicity: Details unknown. See Glycols.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon

tetrachloride (Section 6).
Storage and Handling: Section 6

TRI-n-PROPYL PHOSPHATE
Description: Liquid.
Formula: $(C_3H_7O)_3PO$
Constants:
Mol. Wt. 224
B. P. 97°C @4 mm
Density 1.002 @25°/4°C
Vap. D. 7.72
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of phosphorus; can react with oxidizing materials.
Storage and Handling: Section 7

TRIS (β-CHLOROETHYL) PHOSPHATE
Description: Clear liquid.
Formula: $(ClCH_2CH_2)_3PO_4$
Constants: Mol. Wt. 285.5
Flash P. 421°F (C.O.C.)
Boiling Range: 210 - 220°C @ 20 mm
Density 1.425 @20°/20°C
Autoign. Temp. 1115°F
Vap. Press. 0.5 mm @145°C
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of phosphorus.
Storage and Handling: Section 7

TRIS-CHLOROETHYL PHOSPHITE
Description: Liquid; water white.
Formula: $(ClCH_2CH_2O)_3P$
Constants:
Mol. Wt. 269.51
B. P. 125 - 135°C @7 mm
F. P. > 280°F (O.C.)
Density 1.3348 @35°/4°C
Vap. Press. < 1 mm @20°C
Vap. D. 9.32
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides and oxides of phosphorus; can react vigorously with oxidizing materials; it can isomerize vigorously.
Storage and Handling: Section 7

TRIS(HYDROXYMETHYL) AMINOMETHANE
Description: Crystals.
Formula: $(CH_2OH)_3CNH_2$
Constants:
Mol. Wt. 121.14
M. P. 171 - 172°C
B. P. 219°C @10 mm
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes; can react with oxidizing materials.
Storage and Handling: Section 7

TRIS(HYDROXYMETHYL) NITROMETHANE
Description: Crystalline.
Formula: $(CH_2OH)_3CNO_2$
Constants:
Mol. Wt. 151.12
M. P. 165 - 170°C
B. P. Decomposes
Toxicity: Unknown
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

TRISILANE
Synonym: Trisilicon octahydride.
Description: Liquid.
Formula: Si_3H_8
Constants:
Mol. Wt. 92.2
M. P. -117.4°C
B. P. 52.9°C
Density 0.743 @0°C
Vap. Press. 95.5 mm @0°C
Toxicity: Details unknown. See Silanes.
Fire Hazard: Dangerous, by chemical reaction. Decomposes in water (Section 6).
Explosion Hazard: Severe, by spontaneous chemical reaction. Detonates spontaneously in air.
Disaster Control: Dangerous; shock can shatter the gas container, releasing the contents; when heated to

decomposition it emits toxic fumes and can explode; will react with water or steam to produce hydrogen and toxic fumes; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

TRISILICYLAMINE
Synonym: Nitrilotrisilane.
Description: Liquid.
Formula: $(SiH_3)_3N$
Constants:
Mol. Wt. 107.26
M. P. −105.6°C
B. P. 52°C
Density 0.895 @ −106°C
Toxicity: Details unknown. See Amines and Silanes.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes; will react with water or steam to produce toxic and flammable vapors.
Storage and Handling: Section 7

TRISODIUM-1,3,6-NAPHTHALENE TRISULFONATE
Description: Light tan to buff powder or crystals.
Formula: $C_{10}H_5(SO_3Na)_3$
Constant:
Mol. Wt. 434.4
Toxicity: Unknown
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

TRISODIUM NITROPHOSPHATE
Description: White powder.
Toxicity: Details unknown. See Trisodium Phosphate.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of nitrogen and phosphorus.
Storage and Handling: Section 7

TRISODIUM PHOSPHATE
Synonym: Sodium o-phosphate.
Description: Colorless crystals.
Formula: $Na_3PO_4 \cdot 12H_2O$
Constants:
Mol. Wt. 380.21
M. P. 73.3 - 76.7°C (decomp.); $-12H_2O$ @ 100°C
Density 1.62 @ 20°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: Irritant 2
Chronic Systemic: U
Caution: A strong, caustic material.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of oxides of phosphorus.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

TRISTATE SPECIAL NO. 1. See Explosives High.

TRISTEARYL BORATE
Description: White solid; odor of stearyl alcohol.
Formula: $[CH_3(CH_2)_{16}CH_2O]_3B$
Constants: Mol. Wt. 819.25
M. P. 49.8 - 54°C
B. P. 300 - 331°C @ 0.3 mm
Toxicity: See Boron Compounds and Stearyl Alcohol.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

TRITETRADECYLBORATE
Synonym: Tri(7-ethyl-2-methyl-4 undecyl) borate.
Description: Light straw-yellow, viscous liquid. Slight odor.
Formula: $[CH_3(CH_2)_2CH(C_2H_5) \cdot (CH_2)_2CHO \cdot CH_2CH(CH_3)_2]_3B$
Constants:
Mol. Wt. 650.94
B. P. 225°C @ 0.6 mm
Flash P. 395°F (C.O.C.)
Density 0.846 @ 26°C
Vap. D. 22.5
Toxicity: See Boron Compounds.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TRI(TETRAHYDRO FURFURYL) BORATE
Description: Yellow, mobile liquid;

characteristic odor.
Formula: $[C_4H_7O \cdot CH_2O]_3B$
Constants:
 Mol. Wt. 314.2
 B. P. 321°C
 Flash P. 295°F (C.O.C.)
 Density 1.103 @26.2°C
 Vap. D. 10.8
Toxicity: See Boric Acid and Alcohols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TRITIUM

Synonym: Hydrogen-3.
Description: A colorless, radioactive gas.
Formula: T_2
Constant:
 Mol. Wt. 6.05
Toxicity: See Hydrogen (Radiation Hazard). For further information, refer to Atomic Energy Commission.

TRITOPINE

Synonym: Laudanidine.
Description: White, crystalline alkaloid.
Formula: $C_{20}H_{25}NO_4$
Constants:
 Mol. Wt. 343.41
 M. P. 166°C
Toxic Hazard Rating:
 Acute Local: U
 Acute Systemic: Ingestion 3; Inhalation 3
 Chronic Local: U
 Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition it emits toxic fumes.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

TROJAN COAL POWDERS. See Explosives, High.

"TROLUOIL"

Description: Water-white liquid.
Constants:
 B. P. 90 - 96°C
 Flash P. 25°F
 Density 0.741 @15.5°C
Toxicity: Details unknown. See Petroleum Solvents.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; flammable liquid; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

TROPACAINE HYDROCHLORIDE

Description: Crystalline salt.
Formula: $C_{15}H_{19}NO_2 \cdot HCl$
Constants:
 Mol. Wt. 281.78
 M. P. 271°C
Toxic Hazard Rating:
 Acute Local: U
 Acute Systemic: Ingestion 3; Inhalation 3
 Chronic Local: U
 Chronic Systemic: U
Caution: An alkaloid poison.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

TROPINE

Synonym: N-methyltropoline.
Description: White, crystalline solid.
Formula: $C_8H_{15}NO$
Constants:
 Mol. Wt. 141.21
 M. P. 63°C
 B. P. 233°C
 Density 1.039 @76°/4°C
Toxic Hazard Rating:
 Acute Local: U
 Acute Systemic: Ingestion 3; Inhalation 3
 Chronic Local: U
 Chronic Systemic: Ingestion 2; Inhalation 2
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes.
Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

TROPINE PLATINUM HYDROCHLORIDE

Description: Orange-red, monoclinic tablets.
Formula: $(C_8H_{15}NO \cdot HCl)_2PtCl_4$
Constants:
  Mol. Wt. 692.41
  M. P. 198 - 200°C
Toxicity: See Tropine and Platinum Compounds.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

TRYPARSAMIDE

Synonym: Sodium phenylglycinamine-p-arsonate.
Description: White, crystalline powder.
Formula: $(NH_2COCH_2NHC_6H_4AsOOHONa)_2 \cdot H_2O$
Constant: Mol. Wt. 314.12
Toxicity: Highly toxic. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

TUMERIC

Toxic Hazard Rating:
  Acute Local: Irritant 1; Allergen 1; Ingestion 1; Inhalation 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame.
Personal Hygiene: Section 3
Storage and Handling: Section 7

TUNG NUT MEALS

Toxicity: A weak allergen.
Fire Hazard: Moderate, in the form of dust when exposed to heat or flame; process material and cool thoroughly before storage so as not to over-dry; can react with oxidizing materials.
Storage and Handling: Section 7

TUNG OIL

Synonym: China wood oil.
Description: Thick, yellowish liquid.
Constants: M. P. 31°C
  Flash P. 552°F (C. C.)
  Density 0.94
  Autoign. Temp. 855°F
Toxicity: Details unknown. May act as a weak allergen.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials. Avoid contact of leakage with combustibles. Keep cool and well ventilated.
Spontaneous Heating: Moderate.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

TUNGSTEN

Synonym: Wolfram.
Description: Cubic, gray-black crystals.
Formula: W
Constants: At. Wt. 183.92
  M. P. 3370°C B. P. 5900°C
  Density 19.3
  Vap. Press. 1 mm @3990°C
Toxicity: See Tungsten Compounds.
Radiation Hazard (Section 5): An artificial isotope W^{185}, half-life: 76 days; emits beta particles of 0.43 mev.
Fire Hazard: Moderate, in the form of dust when exposed to flame. See also Powdered Metals.

TUNGSTEN CARBONYL

Description: Colorless, rhombic crystals.
Formula: $W(CO)_6$
Constants: Mol. Wt. 351.98
  M. P. Sublimes 50°C
  B. P. 175°C
  Density 2.65
  Vap. Press. 1.2 mm @67°C
  Vap. D. 12.1
Toxicity: See Carbonyls and Tungsten Compounds.
Fire Hazard: See Carbonyls.
Explosion Hazard: See Carbonyls.
Disaster Control: See Carbonyls.

TUNGSTEN COMPOUNDS

Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Inhalation 1
  Chronic Local: U
  Chronic Systemic: Inhalation 1
Toxicology: Tungsten compounds are

considered somewhat more toxic than those of molybdenum. However, industrially, this element does not constitute an important health hazard. Exposure is related chiefly to the dust arising from the crushing and milling of the two chief ores of tungsten, namely, scheelite and wolframite. There is very little published with reference to its toxicity. The feeding of 2, 5, and 10% of diet as tungsten metal over a period of 70 days has been shown to be without marked effect upon the growth of rats, as measured in terms of gain in weight. Ammonium paratungstate has been found to be much less toxic to rats upon ingestion than either tungstic oxide or sodium tungstate. Recent studies have failed to indicate any serious toxic effect following the inhalation or ingestion of various tungsten compounds, although heavy exposure to the dust or the ingestion of large amounts of the soluble compounds produces a certain rate of mortality in experimental animals.

Ventilation Control (use normal rate): Section 2

TUNGSTEN DISULFIDE

Description: Dark-gray crystals.
Formula: WS_2
Constants:
Mol. Wt. 248.05
Density 7.5 @10°C
Toxicity: See Sulfides and Tungsten Compounds.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.

TUNGSTEN HEXAFLUORIDE

Description: Light-yellow liquid or colorless gas.
Formula: WF_6
Constants:
Mol. Wt. 297.92
M. P. 2.5°C
B. P. 19.5°C
Density Gas: 12.9 g/l; Liquid: 3.44
Toxicity: See Fluorides and Tungsten Compounds.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

TUNGSTEN OXYCYLORIDE

Synonym: Tungsten oxytetrachloride.
Description Red needles.
Formula: $WOCl_4$
Constants:
Mol. Wt. 341.75
M. P. 211°C
B. P. 227.5°C
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

TUNGSTEN PHOSPHIDE

Description: Dark-gray prisms.
Formula: W_2P
Constants:
Mol. Wt. 398.82
Density 5.21
Toxicity: See Phosphides and Tungsten Compounds.
Fire Hazard: See Phosphides.
Explosion Hazard: See Phosphides.
Disaster Control: See Phosphides.
Storage and Handling: Section 7

TUNGSTEN TRISULFIDE

Description: Chocolate-brown powder.
Formula: WS_3
Constant:
Mol. Wt. 280.12
Toxicity: See Sulfides and Tungsten Compounds.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

TURKEY RED OIL

Synonym: Sulfonated castor oil.
Description: A reddish, viscid liquid; characteristic odor.
Constants:
Flash P. 476°F (C.C.)

Density 0.95
Autoign. Temp. 833°F
Toxicity: Unknown
Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: No.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

TURPENTINE (GUM)

Synonym: Gum thus.
Description: Yellowish, opaque, sticky masses.
Toxicity: A mild allergen. See Turpentine Oil.
Fire Hazard: Moderate.
Storage and Handling: Section 7

TURPENTINE OIL

Synonym: Spirit of turpentine
Description: Colorless liquid; characteristic odor.
Formula: Principally $C_{10}H_{16}$
Constants:
Mol Wt. 136
B. P. 154 - 170°C
Flash P. 95°F (C. C.)
Density 0.854 - 0.868 @25°/25°C
Autoign. Temp. 488°F
Vap. D. 4.84
Toxic Hazard Rating:
Acute Local: Irritant 2; Allergen 1
Acute Systemic: Ingestion 3; Inhalation 2; Skin Absorption 2
Chronic Local: Irritant 2; Allergen 2
Chronic Systemic: Ingestion 1; Inhalation 1; Skin Absorption 1
MAC: ACGIH (accepted); 100 parts per million in air; 556 milligrams per cubic meter of air.
Fire Hazard: Moderate, when exposed to heat or flame. Avoid impregnation of leakage with combustibles. Keep cool and ventilated.
Spontaneous Heating: Yes
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate, in the form of vapor when exposed to flame.
Explosive Range: 0.8% (L. E. L.)
Disaster Control: Moderately dangerous; when heated it emits acrid fumes; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Combustible liquid.

TURPENTINE SUBSTITUTES

Synonym: White spirit.
Description: Colorless liquids.
Constant:
Flash P. 80 - 150°F
Toxicity: Variable
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Moderately dangerous; when exposed to heat or open flame; can react with oxidizing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Combustible liquid; inflammable liquid, red label.

TYPE-CLEANING COMPOUNDS, LIQUID

Toxicity: Variable; may contain benzene, carbon tetrachloride or other toxic materials.

TYPEWRITING RIBBONS

Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: 0
Chronic Local: Allergen 1
Chronic Systemic: U
Personal Hygiene: Section 3

TYRAMINE. See Ergot.

U

ULTRA-VIOLET RADIATION

Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: Over exposure may result in systemic effects.
Chronic Local: Irritant 2
Chronic Systemic: 0
Radiation Hazard: Excessive ultraviolet radiation can cause acute inflammation of the eyes as well as burns of the skin. There is some evidence that exposure to ultraviolet radiation over a period of many years may cause cancer of the skin (Section 5).

UNDECANAL

Synonyms: Hendecanal.
Description: Colorless liquid.
Formula: $CH_3(CH_2)_9CHO$
Constants:
Mol. Wt. 170.29
M. P. -4°C
B. P. 117°C @18 mm
Flash P. 235°F (C.O.C.)
Density 0.830 @20°/4°C
Vap. Press. 0.04 mm @20°C
Vap. D. 5.94
Toxic Hazard Rating:
Acute Local: Irritant 2; Ingestion 2; Inhalation 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

UNDECYLENIC ACID

Description: Bright, clear, mobile liquid.
Formula: $H_2CCH(CH_2)_8COOH$
Constants: Mol. Wt. 184.27
M. P. 24.5°C
B. P. 160°C @10 mm
Flash P. 295°F (C.O.C.)
Density 0.910 @25°/25°C
Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

URANIUM

Description: Cubic, silver-white or black crystals.
Formula: U
Constants:
At. Wt. 238.07
M. P. Approx. 1133°C
B. P. Ignites
Density 18.7
Toxicity: Highly toxic. See discussion under Radiation Hazard below.
MAC: ACGIH (accepted); 0.05 milligram per cubic meter of air (for soluble compounds); 0.25 milligram per cubic meter of air (for insoluble compounds).
Radiation Hazard (Section 5): Natural isotope U^{234} (U_{II}), half-life: 2.6×10^5 years; emits alpha particles of 4.76 mev. U^{234} exists in equilibrium with U^{238} in natural uranium compounds. While it is present only to the extent of about 0.0055% by weight, it shows the same alpha activity as the series parent. U^{234} is not found except in the equilibrium state and should be considered with U^{238} in determining hazard.

Natural isotope U^{235} (Actinouranium), half-life: 8.8×10^8 years; emits alpha particles of 4.39 mev (80%) and 4.56 mev (20%) and gamma rays of 0.16 mev. U^{235} is the parent of the actinium series. It is present to the extent of 0.71% in natural uranium. It will not be found separate from U^{238} and U^{234} except in special instances, such as in the separation required in the preparation of atomic weapons. It should be considered in connection with U^{238} and U^{234} in determining hazard.

Natural isotope U^{238}, half-life: 4.5×10^9 years; emits alpha particles of 4.18 mev. The permissible levels for $U^{238} + U^{234} + U^{235}$ in natural ratio are: Soluble compounds: In body: 0.2 microcurie; in air: 1.7×10^{-11} microcurie per milliliter; in water: 7×10^{-5} microcurie per milliliter. Insoluble compounds: In body: 0.009 microcurie; in air: 1.7×10^{-11} microcurie per milliliter.

U^{238} is the parent of the uranium series (see Section 5). It occurs in natural uranium to the extent of 99.3%.

The permissible levels for soluble compounds and the level for insoluble compounds in air are based on chemical toxicity, while the permissible body level for insoluble compounds is based on radiotoxicity.

The high chemical toxicity of uranium and its salts is largely shown in kidney damage, and acute necrotic arterial lesions. The rapid passage of soluble uranium compounds through the body tends to allow relatively large amounts to be taken in. The highly toxic effect of insoluble compounds is largely due to lung irradiation by inhaled particles. This material is transferred from the lung of animals quite slowly. The final deposition of uranium in the bone structure could be considered in terms of an equivalent activity of radium, that is, 0.1 microcurie would be the permissible level.

Fire Hazard: Dangerous, in the form of a solid or dust when exposed to heat or flame (Section 6).

Explosion Hazard: Moderate, in the form of dust when exposed to flame.

Disaster Control: For further information refer to Atomic Energy Commission.

Ventilation Control (use moderate rate): Sections 5 and 2.

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

URANIUM AMMONIUM FLUORIDE

Synonym: Ammonium uranium fluoride.

Description: Greenish-yellow crystalline powder.

Formula: $UO_2F_2 \cdot 3NH_4F$

Constant:

Mol. Wt. 419.2

Toxicity: See Uranium and Fluorides.

Radiation Hazard: See Uranium.

Disaster Control: See Uranium and Fluorides.

Storage and Handling: Section 7

URANIUM AMMONIUM PENTAFLUORIDE

Description: Tetragonal crystals.

Formula: $(NH_4)_3UO_2F_5$

Constants:

Mol. Wt. 419.2

M. P. Decomposes

Toxicity: See Uranium and Fluorides.

Radiation Hazard: See Uranium.

Disaster Control: See Uranium and Fluorides.

Storage and Handling: Section 7

URANIUM BARIUM OXIDE

Synonym: Barium diuranate.

Description: Yellow or orange powder.

Formula: BaU_2O_7

Constant:

Mol. Wt. 725.50

Toxicity: See Uranium and Barium Compounds.

Radiation Hazard: See Uranium.

URANIUM BORIDE

Synonym: Uranium diboride.

Description: Hexagonal crystals.

Formula: UB_2

Constants:

Mol. Wt. 248.9

M. P. 2365°C

Density 12.70

Toxicity: See Uranium.

Radiation Hazard: See Uranium.

Fire Hazard: Moderate; can react with moisture or acids to evolve boron hydride. See also Boron

Hydrides.
Explosion Hazard: Moderate; can react with moisture or acids to evolve boron hydrides. See also Boron Hydrides.
Disaster Control: Moderately dangerous; it will react with water or steam to produce toxic and flammable vapors; it can react with oxidizing materials; and on contact with acid or acid fumes, it can emit toxic fumes.
Storage and Handling: Section 7

URANIUM CARBIDE
Description: Gray crystals.
Formula UC_2
Constants:
Mol. Wt. 262.09
M. P. 2260°C
B. P. 4100°C
Density 11.28 @18°C
Toxicity: See Uranium.
Radiation Hazard: See Uranium.
Fire Hazard: See Carbides.
Explosion Hazard: See Carbides.
Disaster Control: See Carbides and Uranium.
Storage and Handling: Section 7

URANIUM DIOXIDE
Description: Rhombic or cubic, brown-black crystals.
Formula: UO_2
Constants:
Mol. Wt. 270.07
M. P. 2176°C
Density 10.9
Toxicity: See Uranium.
Radiation Hazard: See Uranium.

URANIUM DISULFIDE
Description: Tetragonal, gray-black crystals.
Formula: US_2
Constants:
Mol. Wt. 302.20
M. P. > 1100°C
B. P. Oxidizes
Toxicity: See Uranium and Sulfides.
Radiation Hazard: See Uranium.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides and Uranium.
Storage and Handling: Section 7

URANIUM HEXAFLUORIDE
Description: Monoclinic, colorless-pale yellow, deliquescent crystals.
Formula: UF_6
Constants:
Mol. Wt. 352.07
M. P. 69.2°C @2 atm.
B. P. 56.2°C @764.6 mm
Density 4.68 @20.7°C
Vap. Press. 100 mm @18.2°C
Toxicity: See Uranium and Fluorides.
Radiation Hazard: See Uranium.
Disaster Control: See Fluorides and Uranium.
Storage and Handling: Section 7

URANIUM NITRIDE
Description: Brown-black crystals.
Formula: U_3N_4
Constants:
Mol. Wt. 770.24
Density 10.09
Toxicity: See Uranium.
Radiation Hazard: See Uranium.

URANIUM OXYACETATE
Synonym: Uranyl acetate.
Description: Rhombic, yellow crystals.
Formula: $UO_2(C_2H_3O_2)_2 \cdot 2H_2O$
Constants:
Mol. Wt. 424.19
M. P. $-2H_2O$ @110°C
B. P. Decomposes 275°C
Density 2.893 @15°C
Toxicity: See Uranium.
Radiation Hazard: See Uranium.

URANIUM OXYAMMONIUM CARBONATE
Synonym: Uranyl ammonium carbonate.
Description: Monoclinic, yellow crystals.
Formula: $2(NH_4)_2CO_3 \cdot UO_2CO_3 \cdot 2H_2O$
Constants:
Mol. Wt. 558.29
M. P. Decomposes @100°C
Density 2.773
Toxicity: See Uranium.
Radiation Hazard: See Uranium

URANIUM OXYAMMONIUM CHLORIDE
Synonym: Uranyl ammonium chloride.
Description: Greenish-yellow, deliquescent crystals.
Formula: $UO_2 \cdot Cl_2 \cdot 2NH_4Cl \cdot 2H_2O$
Constant: Mol. Wt. 484.0
Toxicity: See Uranium.
Radiation Hazard: See Uranium.

URANIUM OXYBENZOATE
Synonym: Uranyl benzoate.
Description: Yellow powder.
Formula: $UO_2(C_7H_5O_2)_2$
Constant: Mol. Wt. 512.29
Toxicity: See Uranium.
Radiation Hazard: See Uranium.
Storage and Handling: Section 7

URANIUM OXYBROMIDE
Synonym: Uranyl bromide.
Description: Green-yellow, hygroscopic needles.
Formula: UO_2Br_2
Constant:
Mol. Wt. 429.90
Toxicity: See Uranium.
Radiation Hazard: See Uranium.
Storage and Handling: Section 7

URANIUM OXYCHLORIDE
Synonym: Uranyl chloride.
Description: Yellow, deliquescent crystals.
Formula: UO_2Cl_2
Constants:
Mol. Wt. 340.98
M. P. < red heat
Toxicity: See Uranium.
Radiation Hazard: See Uranium.
Disaster Control: When heated to decomposition it emits highly toxic fumes.
Storage and Handling: Section 7

URANIUM OXYFORMATE
Synonym: Uranyl formate.
Description: Yellow crystals.
Formula $UO_2(CHO_2)_2 \cdot H_2O$
Constants:
Mol. Wt. 378.12
M. P. $-H_2O$ @110°C
Density 3.695 @19°C
Toxicity: See Uranium.
Radiation Hazard: See Uranium.

URANIUM OXYIODATE
Synonym: Uranyl iodate.
Description: Rhombic, yellow crystals.
Formula: $UO_2(IO_3)_2$
Constants: Mol. Wt. 619.91
M. P. Decomposes 250°C
Density 5.2
Toxicity: See Uranium.
Radiation Hazard: See Uranium
Fire Hazard: See Iodates.
Explosion Hazard: See Iodates.
Disaster Control: See Iodates.
Storage and Handling: Section 7

URANIUM OXYIODIDE
Synonym: Uranyl iodide.
Description: Red, deliquescent crystals.
Formula: UO_2I_2
Constants:
Mol. Wt. 523.91
M. P. Decomposes in air.
Toxicity: See Uranium.
Radiation Hazard: See Uranium.
Disaster Control: See Iodides.
Storage and Handling: Section 7

URANIUM OXYMONOHYDROGEN PHOSPHATE
Synonym: Uranyl monohydrogen phosphate.
Description: Tetragonal, yellow plates.
Formula: $UO_2HPO_4 \cdot 4H_2O$
Constant: Mol. Wt. 438.12
Toxicity: See Uranium.
Radiation Hazard: See Uranium.

URANIUM OXYNITRATE
Synonym: Uranyl nitrate.
Description: Rhombic, yellow, deliquescent crystals.
Formula: $UO_2(NO_3)_2 \cdot 6H_2O$
Constants:
Mol. Wt. 502.18
M. P. 60.2°C; decomp. 100°C
Density 2.807 @13°C
Toxicity: See Uranium.
Radiation Hazard: See Uranium.
Fire Hazard: See Nitrates.
Explosion Hazard: Unknown
Disaster Control: See Nitrates.
Storage and Handling: Section 7

URANIUM OXYOXALATE
Synonym: Uranyl oxalate.
Description: Yellow crystals.
Formula: $UO_2C_2O_4 \cdot 3H_2O$
Constants: Mol. Wt. 412.14
M. P. $-H_2O$ @110°C
Toxicity: See Uranium.
Radiation Hazard: See Uranium.

URANIUM OXYPERCHLORATE
Synonym: Uranyl perchlorate.
Description: Yellow, deliquescent crystals.
Formula: $UO_2(ClO_4)_2 \cdot 6H_2O$
Constants:
Mol. Wt. 545.07

M. P. 90°C; decomp. @110°C
Toxicity: See Uranium.
Radiation Hazard: See Uranium.
Fire Hazard: See Perchlorates.
Explosion Hazard: See Perchlorates.
Disaster Control: See Perchlorates.
Storage and Handling: Section 7

URANIUM OXYSULFATE

Synonym: Uranyl sulfate.
Description: Yellow-green crystals.
Formula: $UO_2SO_4 \cdot 3H_2O$
Constants: Mol. Wt. 420.18
M. P. Decomposes @100°C
Density 3.28 @16.5°C
Toxicity: See Uranium.
Radiation Hazard: See Uranium

URANIUM OXYSULFIDE

Synonym: Uranyl sulfide.
Description: Brown-black, tetragonal crystals.
Formula: UO_2S
Constants: Mol. Wt. 302.14
M. P. Decomposes 40 - 50°C
Toxicity: See Uranium.
Radiation Hazard: See Uranium.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

URANIUM OXYSULFITE

Synonym: Uranyl sulfite.
Description: Pale-green crystals.
Formula: $UO_2SO_3 \cdot 4H_2O$
Constant: Mol. Wt. 422.20
Toxicity: See Uranium.
Radiation Hazard: See Uranium.
Disaster Control: See Sulfites.
Storage and Handling: Section 7

URANIUM PENTACHLORIDE

Description: Dark green-gray needles; red by trans. light, deliquescent.
Formula: UCl_5
Constants: Mol. Wt. 415.36
M. P. Decomposes @120°C
Toxicity: See Uranium
Radiation Hazard: See Uranium
Disaster Control: Dangerous; when heated to decompositoin it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

URANIUM PEROXIDE

Description: Pale yellow, hygroscopic crystals.
Formula: $UO_4 \cdot 2H_2O$
Constants:
Mol. Wt. 338.10
M. P. Decomposes @115°C
Toxicity: See Uranium.
Radiation Hazard: See Uranium.
Fire Hazard: See Peroxides.
Disaster Control: See Peroxides, Inorganic.
Storage and Handling: Section 7

URANIUM PHOSPHATE

Synonyms: Mono-uranyl o-phosphate; uranyl phosphate.
Description: Tetragonal, yellow plates.
Formula: $UO_2HPO_4 \cdot 4H_2O$
Constant: Mol. Wt. 438.16
Toxicity: See Uranium.
Radiation Hazard: See Uranium.

URANIUM POTASSIUM NITRATE

Synonyms: Potassium uranium nitrate; uranyl potassium nitrate.
Description: Yellow, crystalline powder.
Formula: $(KNO_3)_2 \cdot UO_2(NO_3)_2$
Constant:
Mol. Wt. 394.086
Toxicity: See Uranium.
Radiation Hazard: See Uranium.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

URANIUM POTASSIUM SULFATE

Synonym: Potassium uranyl sulfate.
Description: Monoclinic, yellow crystals.
Formula: $K_2SO_4 \cdot UO_2SO_4 \cdot 2H_2O$
Constants:
Mol. Wt. 576.41
M. P. $-2H_2O$ @120°C
Density 3.363 @19.1°C
Toxicity: See Uranium.
Radiation Hazard: See Uranium.

URANIUM SESQUISULFIDE

Description: Gray-black needles.
Formula: U_2S_3
Constants:
Mol. Wt. 572.34
M. P. Ignites
Toxicity: See Uranium.
Radiation Hazard: See Uranium.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

URANIUM SODIUM OXYACETATE
Synonym: Sodium uranyl acetate.
Description: Yellow crystals.
Formula: $NaUO_2(C_2H_3O_2)_3$
Constants: Mol. Wt. 470.20
Density 2.56
Toxicity: See Uranium.
Radiation Hazard: See Uranium.

URANIUM STRONTIUM OXIDE
Synonym: Strontium diuranate.
Description: Yellow powder.
Formula: SrU_2O_7
Constant: Mol. Wt. 675.77
Toxicity: See Uranium.
Radiation Hazard: See Uranium.

URANIUM TETRABROMIDE
Description: Brown, deliquescent leaflets.
Formula: UBr_4
Constants: Mol. Wt. 557.73
B. P. Volatilizes
Density 4.84 @21°/4°C
Toxicity: See Uranium.
Radiation Hazard: See Uranium.
Disaster Control: See Bromides.
Storage and Handling: Section 7

URANIUM TETRACHLORIDE
Description: Cubic, dark green-gray deliquescent crystals.
Formula: UCl_4
Constants:
Mol. Wt. 379.90
M. P. Sublimes
B. P. 618°C
Density 4.725 @25°/4°C
Toxicity: See Uranium.
Radiation Hazard: See Uranium.
Disaster Control: Dangerous; when heated to decomposition, it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

URANIUM TETRAFLUORIDE
Description: Green, amorphous powder.
Formula: UF_4
Constants:
Mol. Wt. 314.07
M. P. Approx. 1000°C
Toxicity: See Uranium and Fluorides.
Radiation Hazard: See Uranium.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

URANIUM TETRAIODIDE
Description: Black needles.
Formula: UI_4
Constants:
Mol. Wt. 745.75
M. P. 500°C
Density 5.6 @15°C
Toxicity: See Uranium.
Radiation Hazard: See Uranium.
Disaster Control: See Iodides.
Storage and Handling: Section 7

URANIUM TRIBROMIDE
Description: Dark brown, hygroscopic needles.
Formula: UBr_3
Constants:
Mol. Wt. 477.82
B. P. Volatilizes
Toxicity: See Uranium
Radiation Hazard: See Uranium.
Disaster Control: See Bromides.
Storage and Handling: Section 7

URANIUM TRICHLORIDE
Description: Dark red, hygroscopic needles.
Formula: UCl_3
Constants:
Mol. Wt. 344.44
Density 5.44 @25°/4°C
Toxicity: See Uranium.
Radiation Hazard: See Uranium.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

URANIUM TRIOXIDE
Synonym: Uranyl oxide.
Description: Yellow-red powder.
Formula: UO_3
Constants:
Mol. Wt. 286.07
M. P. Decomposes
Density 7.29
Toxicity: See Uranium.
Radiation Hazard: See Uranium.

URANOUS SULFATE
Description: Rhombic green.
Formula: $U(SO_4)_2 \cdot 4H_2O$
Constants:
Mol. Wt. 502.27
M. P. $-4H_2O$ @300°C
Toxicity: See Uranium.
Radiation Hazard: See Uranium.

UREA
Synonym: Carbamide.
Description: White crystals or powder.

Formula: $(NH_2)_2CO$
Constants: Mol. Wt. 60.1
M. P. 132.7°C
B. P. Decomposes
Density 1.335
Toxicity: No importance as an industrial hazard.
Disaster Control: Slightly dangerous when heated.
Storage and Handling: Section 7

UREA NITRATE, WET NOT EXCEEDING 16 OZ. WITH NOT LESS THAN 10% WATER

Formula: $CO(NH_2)_2HNO_3$ (varying with moisture content)
Constant: Mol. Wt. 123.08
Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: U
Chronic Local: Irritant 1
Chronic Systemic: U
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: See Section 11, §73.192
Coast Guard Classification: Inflammable solid.

UREA NITRATE, WET, WITH NOT LESS THAN 10% WATER IN EXCESS OF 16 OZ., BUT NOT EXCEEDING 25 LBS.

See Urea Nitrate, Wet.
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

UREA PEROXIDE

Synonym: Urea hydrogen peroxide.
Description: White crystals.
Formula: $CO(NH_2)_2 \cdot H_2O_2$
Constants:
Mol. Wt. 94.08
M. P. 75 - 85°C (decomp.)
Toxic Hazard Rating:
Acute Local: Irritant 2
Acute Systemic: U
Chronic Local: U
Chronic Systemic: U
Fire Hazard: See Peroxides, Organic.
Disaster Control: See Peroxides, Organic.
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

URIC ACID

Synonyms: Lithic acid; uric oxide.
Description: White crystals.
Formula: $CO(NH)_2COC_2CO(NH)_2$
Constants:
Mol. Wt. 168.11
M. P. Decomposes to hydrogen cyanide.
Density 1.855 - 1.893
Toxicity: It can evolve hydrogen cyanide when heated. See also Cyanides.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of cyanides.
Storage and Handling: Section 7

V

gamma-**VALEROLACTONE**
Description: Colorless, mobile liquid.
Formula: ($C_5H_8O_2$)
Constants:
  Mol. Wt. 100.06
  M. P. −31°C
  B. P. 205 - 206.5°C
  Flash P. 205°F
  Density 1.0518 @25°/25°C
  Vap. D. 3.45
Toxicity: Details unknown; probably low.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

VALYL
Synonyms: Diethyl valeramide; valeryl diethylamide.
Description: Colorless liquid; burning taste.
Formula: $C_4H_9CON(C_2H_5)_2$
Constants:
  Mol. Wt. 157.25
  B. P. 210°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 1
  Chronic Local: U
  Chronic Systemic: Ingestion 1
Caution: May have a depressant action.
Fire Hazard: Slightly dangerous; when heated, it will burn and emit toxic fumes (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

VANADIUM
Description: Light-gray crystalline metal
Formula: V
Constants: At. Wt. 50.95
  M. P. 1720 ± 20°C
  B. P. 3000°C
  Density 5.866 @15°C
Toxicity: See Vanadium Compounds.
Radiation Hazard (Section 5): Artificial isotope V^{48}, half-life: 16 days; emits gamma rays between 0.99 - 1.3 mev and positron particles of 0.8 mev. The permissible levels are: In body: 20 microcuries; in air: 10^{-6} microcurie per milliliter; in water: 0.5 microcurie per milliliter.
Fire Hazard: Moderate in the form of dust when exposed to heat or flame (Section 6).
Storage and Handling: Section 7

VANADIUM COMPOUNDS
Toxicity: Variable. Vanadium compounds act chiefly as irritants to the conjunctivae and respiratory tract. Prolonged exposures may lead to pulmonary involvement. There is still some controversy as to the effects of industrial exposure on other systems of the body. Responses are acute, never chronic.

The first report of vanadium poisoning in humans described rather widespread systemic effects, consisting of polycythemia, followed by red blood cell destruction and anemia, loss of appetite, pallor and emaciation, albuminuria and hematuria, gastrointestinal disorders, nervous complaints and cough, sometimes severe enough to cause hemoptysis. More recent reports describe symptoms which, for the most part, are restricted to the conjunctivae and respiratory system, no evidence being found of disturbances of the gastrointestinal tract, kidneys, blood or central nervous system. Though certain workers believe that it is only the pentoxide which is harmful, other investigators have found that patronite dust (chiefly vanadium sulfide) is quite toxic to animals, causing acute pulmonary edema.

Symptoms and signs of poisoning are pallor, greenish-black discoloration of the tongue, paroxysmal cough, conjunctivitis, dyspnea and pain in the chest, bronchitis, rales and ronchi, broncho-spasm, tremor of the fingers and arms, radiographic reticulation. See also specific compounds.

MAC: ACGIH (tentative); V_2O_5 Dust = 0.5; V_2O_5 Fume = 0.1 milligrams per cubic meter in air.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3

VANADIUM DIBORIDE

Description: Hexagonal crystals.
Formula: VB_2
Constants:
Mol. Wt. 72.59
Density 5.10
Toxicity: See Vanadium Compounds and Boron Compounds.
Fire Hazard: Moderate; on contact with moisture or acids, hydrides can be formed. See also Boron Hydrides.
Explosion Hazard: Slight; on contact with moisture or acids, hydrides can be formed. See also Boron Hydrides.
Disaster Control: Moderately dangerous; it will react with water or steam to produce toxic and flammable vapors; can react with oxidizing materials; and on contact with acid or acid fumes, it can emit toxic fumes.
Storage and Handling: Section 7

VANADIUM DICHLORIDE

Synonym: Vanadous chloride.
Description: Hexagonal, green plates; deliquescent.
Formula: VCl_2
Constants:
Mol. Wt. 121.86
Density 3.23 @18°C
Toxicity: See Hydrochloric Acid and Vanadium Compounds.
Disaster Control: Dangerous, when heated to decomposition it emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

VANADIUM IODIDE

Description: Green, deliquescent crystals.
Formula: $VI_3 \cdot 6H_2O$
Constant:
Mol. Wt. 539.81
Toxicity: See Vanadium Compounds and Iodides.
Disaster Control: See Iodides.
Storage and Handling: Section 7

VANADIUM MONOSULFIDE

Synonym: Vanadium sulfide.
Description: Black plates.
Formula: VS
Constants:
Mol. Wt. 83.02
M. P. Decomposes
Density 4.20
Toxicity: See Sulfides and Vanadium Compounds.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

VANADIUM MONOXIDE

Synonym: Vanadium oxide.
Description: Light-gray crystals.
Formula: VO
Constants:
Mol. Wt. 66.95
M. P. Ignites
Density 5.758 @14°C
Toxicity: See Vanadium Compounds.
Fire Hazard: Moderate, when heated (Section 6).
Storage and Handling: Section 7

VANADIUM OXYBROMIDE

Description: Violet crystals.
Formula: VOBr
Constants:
Mol. Wt. 146.87
M. P. Decomposes @480°C
Density 4.00 @18°C
Toxicity: See Vanadium Compounds and Bromides.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of bromides.
Storage and Handling: Section 7

VANADIUM OXYCHLORIDE
Description: Yellow-brown powder.
Formula: VOCl
Constants:
Mol. Wt. 102.41
B. P. 127°C
Density 3.64 @20°C
Toxicity: See Vanadium Compounds.
Disaster Control: Dangerous; when heated to decomposition it emits toxic fumes of chlorides.
Storage and Handling: Section 7

VANADIUM OXYDIBROMIDE
Description: Brown, deliquescent powder.
Formula: $VOBr_2$
Constants:
Mol. Wt. 226.78
M. P. Decomposes @180°C
Toxicity: See Vanadium Compounds and Bromides.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of bromides.
Storage and Handling: Section 7

VANADIUM OXYDICHLORIDE
Synonyms: Hypovanadic hydrochloride; vanadylchloride.
Description: Dark green, syrupy mass.
Formula: $VOCl_2$
Constants:
Mol. Wt. 137.86
Density 2.88 @13°C
Toxicity: See Vanadium Compounds.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

VANADIUM OXYDIFLUORIDE
Description: Yellow solid.
Formula: VOF_2
Constants:
Mol. Wt. 104.95
M. P. Decomposes
Density 3.396 @19°C
Toxicity: See Fluorides and Vanadium Compounds.
Disaster Control: See Fluorides.

VANADIUM OXYTRIBROMIDE
Description: Red liquid.
Formula: $VOBr_3$
Constants:
Mol. Wt. 306.70
M. P. Decomposes @180°C
B. P. 130°C @100 mm
Density 2.933 @14.5°C
Toxicity: See Vanadium Compounds and Bromides.
Disaster Control: See Bromides.
Storage and Handling: Section 7

VANADIUM OXYTRICHLORIDE
Description: Yellow, deliquescent liquid.
Formula: $VOCl_3$
Constants:
Mol. Wt. 173.32
M. P. −77 ± 2°C
B. P. 126.7°C
Density 1.829
Toxicity: See Vanadium Compounds and Hydrochloric Acid.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

VANADIUM OXYTRIFLUORIDE
Description: Yellow-white, hygroscopic crystals.
Formula: VOF_3
Constants:
Mol. Wt. 123.95
M. P. 300°C
B. P. 480°C
Density 2.459 @19°C
Toxicity: See Fluorides and Vanadium Compounds.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

VANADIUM PENTAFLUORIDE
Description: Crystals.
Formula: VF_5
Constants:
Mol. Wt. 145.95
B. P. 111.2°C
Density 2.177 @19°C
Toxicity: See Fluorides and Vanadium Compounds.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

VANADIUM PENTASULFIDE
Description: Black-green powder.
Formula: V_2S_5
Constants:
Mol. Wt. 262.2
M. P. Decomposes
Density 3.00
Toxicity: See Sulfides and Vanadium Compounds.
Fire Hazard: See Sulfides.

Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

VANADIUM PENTOXIDE

Description: Yellow to red crystalline powder.
Formula: V_2O_5
Constants:
  Mol. Wt. 181.90
  M. P. 690°C
  B. P. Decomposes @1750°C
  Density 3.357 @18°C
Toxicity: See Vanadium Compounds.

VANADIUM SESQUIOXIDE

Synonym: Vanadium trioxide.
Description: Black crystals.
Formula: V_2O_3
Constants:
  Mol. Wt. 149.9
  M. P. 1970°C
  Density 4.87 @18°C
Toxicity: See Vanadium Compounds.

VANADIUM SESQUISULFIDE

Synonym: Vanadium trisulfide.
Description: Green-black plates or powder.
Formula: V_2S_3
Constants:
  Mol. Wt. 198.1
  M. P. Decomposes
  Density 4.7 @21°C
Toxicity: See Sulfides and Vanadium Compounds.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

VANADIUM SULFIDE

Description: Black plates.
Formula: V_2S_2
Constants:
  Mol. Wt. 166.02
  M. P. Decomposes
  Density 4.20
Toxicity: See Sulfides and Vanadium Compounds.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

VANADIUM TETRACHLORIDE

Description: Reddish-brown liquid.
Formula: VCl_4
Constants:
  Mol. Wt. 192.78
  M. P. −28 ± 2°C
  B. P. 148.5°C
  Density 1.816 @30°C
Toxicity: See Hydrochloric Acid and Vanadium Compounds.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides; will react with water or steam to produce heat, toxic and corrosive fumes.
Storage and Handling: Section 7

VANADIUM TETRAFLUORIDE

Description: Brown-yellow crystals.
Formula: VF_4
Constants:
  Mol. Wt. 127.0
  M. P. Decomposes @325°C
  Density 2.975 @23°C
Toxicity: See Fluorides and Vanadium Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes it emits highly toxic fumes of fluorides; will react with water or steam to produce toxic and corrosive fumes.
Storage and Handling: Section 7

VANADIUM TETRAOXIDE

Synonym: Vanadium dioxide.
Description: Black crystals.
Formula: V_2O_4
Constants:
  Mol. Wt. 165.90
  M. P. 1967°C
  Density 4.339
Toxicity: See Vanadium Compounds.

VANADIUM TRIBROMIDE

Description: Green-black, deliquescent crystals.
Formula: VBr_3
Constants:
  Mol. Wt. 290.8
  M. P. Decomposes
Toxicity: See Vanadium Compounds and Bromides.
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes of bromides.
Storage and Handling: Section 7

VANADIUM TRICHLORIDE
Description: Pink crystals.
Formula: VCl_3
Constants:
  Mol. Wt. 157.32
  M. P. Decomposes
  Density 3.00 @18°C
Toxicity: See Vanadium Compounds and Hydrochloric Acid.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

VANADIUM TRIFLUORIDE
Description: Rhombic green crystals.
Formula: VF_3
Constants:
  Mol. Wt. 108.0
  M. P. > 800°C
  B. P. Sublimes
  Density 3.363 @19°C
Toxicity: See Fluorides and Vanadium Compounds.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

VANADIUM TRIOXIDE. See Vanadium Sesquioxide.

VANADYL SULFATE
Synonyms: Vanadic sulfate; vanadium sulfate.
Description: Blue crystals.
Formula: $VOSO_4$
Constant:
  Mol. Wt. 163.01
Toxicity: See Vanadium Compounds.

VANILLA
Description: Cured, full-grown unripe fruit of Vanilla planifolia.
Composition: 2-3% Vanillin; 4% resin; 10% sugar, etc.
Toxic Hazard Rating:
  Acute Local: Irritant 1; Allergen 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 3

VARNISH
Description: Usually contains oil, resins and solvents.
Constant:
  Flash P. Less than 80°F
Toxicity: Variable as an allergen. See specific components.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; keep away from heat and open flame; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11
  Coast Guard Classification: Combustible liquid; inflammable liquid, red label.

VARNISH MAKERS' NAPHTHA.
See Naphtha.

VARNISH SHELLAC
Constant:
  Flash P. 40 - 70°F
Toxicity: Details unknown; a variable allergen. See also specific component.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Carbon dioxide, dry chemical, or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; keep away from heat or open flame; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

VARNOLINE
Synonym: Safety solvent.
Constant:
  Flash P. 109°F (C.C.)
Toxicity: Details unknown. See Kerosene.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7

VEGETABLE OIL, HYDROGENATED

Constants:
- Flash P. 610°F (O. C.)
- Density Less than 1

Fire Hazard: Slight, when exposed to heat or flame.

To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

VERATRIDINE

Description: Yellow-white powder.

Formula: $C_{36}H_{51}NO_{11}$

Constants:
- Mol. Wt. 673.8
- M. P. 180°C

Toxicity: Details unknown; an insecticide. See also Veratrine.

Fire Hazard: Slight; when heated it emits toxic fumes (Section 6).

Storage and Handling: Section 7

VERATRINE

Synonym: Cevadine.

Description: White-to-gray powder.

Formula: $C_{32}H_{44}NO_9$

Constants:
- Mol. Wt. 586.7
- M. P. 145 -155°C

Toxic Hazard Rating:
- Acute Local: U
- Acute Systemic: Ingestion 3
- Chronic Local: U
- Chronic Systemic: U

Caution: Action is similar to that of digitalis.

Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes.

Ventilation Control (use normal rate): Section 2

Personal Hygiene: Section 3

Storage and Handling: Section 7

VERATRINE SULFATE. See Veratrine.

VIGORITE NO. 5 L.F. See Explosives, High.

VINEGAR

Description: Clear to yellow liquid.

Composition: Approximately 6% solution of acetic acid.

Toxicity: See Acetic Acid.

Disaster Control: See Acetic Acid.

VINYL ACETATE

Description: Colorless, mobile liquid, polymerizes to solid on exposure to light.

Formula: $CH_3COOCHCH_2$

Constants: Mol. Wt. 86.05
- M. P. -100.2°C
- B. P. 73°C
- Flash P. -20°F (C. O. C.)
- Density 0.9335 @20°C
- Autoign. Temp. 800°F
- Vap. Press. 100 mm at 21.5°C

Toxic Hazard Rating:
- Acute Local: Irritant 2
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Highly dangerous when exposed to heat or flame.

Spontaneous Heating: No

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Explosion Hazard: Unknown.

Disaster Control: Dangerous; when heated to decomposition it burns and emits acrid fumes; can react with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations: Section 11
- I. C. C. Classification: Flammable liquid; red label.
- Coast Guard Classification: Inflammable liquid; red label.

VINYL ALCOHOL

Synonyms: Ethenol; vinol.

Description: An unstable liquid. Isolated only in form of its esters or the polymer, polyvinyl alcohol.

Formula: CH_2CHOH

Constant: Mol. Wt. 44.1

Toxicity: Details unknown. See Alcohols.

Fire Hazard: Dangerous, when exposed to heat or flame (Section 6).

Explosion Hazard: Unknown

Disaster Control: Dangerous, when exposed to heat or open flame; can react vigorously with oxidizing materials.

Ventilation Control (use normal rate): Section 2

Storage and Handling: Section 7

VINYL BENZENE. See Styrene.

VINYL BROMIDE

Synonyms: Bromoethylene; bromoethene.
Description: A gas.
Formula: CH_2CHBr
Constants:
  Mol. Wt. 107.0
  M. P. -138°C
  B. P. 15.6°C
  Density 1.51
Toxic Hazard Rating:
  Acute Local: Inhalation 2
  Acute Systemic: Inhalation 2
  Chronic Local: U
  Chronic Systemic: Inhalation 2
Fire Hazard: Dangerous, when exposed to flame or heat.
To Fight Fire: Carbon dioxide, dry chemical or water spray (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of bromine and bromine compounds; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

VINYL BUTYL "CELLOSOLVE"

Description: Liquid.
Formula: $CH_2CHOCH_2CH_2OC_4H_9$
Constants:
  Mol. Wt. 144.21
  M. P. -71°C
  B. P. 88°C @ 50 mm
  Density 0.8654 @ 20°/20°C
  Vap. D. 4.98
Toxicity: See Glycols.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Disaster Control: Moderately dangerous when exposed to heat or flame; can react with oxidizing materials.
Storage and Handling: Section 7

VINYL BUTYL ETHER

Description: Liquid.
Formula: $CH_2CHOC_4H_9$
Constants:
  Mol. Wt. 100.16
  M. P. -112.7°C
  B. P. 94.1°C
  Flash P. 15°F (O. C.)
  Density 0.7803 @ 20°/20°C
  Vap. D. 3.45
Toxicity: Details unknown. See Ethers.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Details unknown. See Ethers.
Disaster Control: Highly dangerous, when exposed to heat or flame; can react with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

VINYL CARBAZOLE

Description: Liquid.
Formula: $(C_6H_4)_2NCHCH_2$
Constant:
  Mol. Wt. 193.2
Toxic Hazard Rating:
  Acute Local: Allergen 1
  Acute Systemic: U
  Chronic Local: Irritant 1; Allergen 1
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: Unknown
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

VINYL 2-CHLORETHYL ETHER

Description: Liquid.
Formula: $CH_2CHOCH_2CH_2Cl$
Constants:
  Mol. Wt. 106.55
  M. P. -70.3°C
  B. P. 108.9°C
  Flash P. 80°F (O. C.)
  Density 1.0498
  Vap. D. 3.67
Toxicity: Details unknown. See Ethers.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Details unknown. See Ethers.
Disaster Control: Dangerous when

heated to decomposition it emits highly toxic fumes of phosgene; can react vigorously with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

VINYL CHLORIDE

Synonyms: Chloroethylene; chloroethene.
Description: Colorless liquid or gas (when inhibited); faintly sweet odor.
Formula: CH_2CHCl
Constants: Mol. Wt. 62.50
  B. P. −13.4°C
  Flash P. −108°F (C.O.C.)
  Freezing P. −153.8°C
  Density Liquid: 0.9195 @ 15°/4°C
  Vap. Press. 2660 mm @25°C
  Vap. D. 2.15
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Ingestion 2; Inhalation 2
  Chronic Local: U
  Chronic Systemic: Ingestion 1; Inhalation 1
MAC: ACGIH (accepted); 500 parts per million in air; 1290 milligrams per cubic meter of air.
Caution: May cause local irritation or frostbite due to rapid evaporation from skin or tissues.
Fire Hazard: Dangerous, when exposed to heat or flame. Large fires of this material are practically inextinguishable.
Spontaneous Heating: No
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Severe in the form of vapor when exposed to heat or flame.
Explosive Range: 4 - 22%.
Disaster Control: Very dangerous; when heated to decomposition it emits highly toxic fumes of phosgene; can react vigorously with oxidizing materials. Before storing or handling this material instructions for its use should be obtained from the supplier.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable gas; red gas label.
  Coast Guard Classification: Inflammable gas; red gas label.
  MCA warning label.

VINYL CYANIDE. See Acrylonitrile.

4-VINYL CYCLOHEXENE-1

Description: Liquid.
Formula: C_8H_{12}
Constants: Mol. Wt. 108.18
  B. P. 128°C
  Freezing P. −109°C
  Flash P. 70°F (T.O.C.)
  Density 0.832 @20°/4°C
  Autoign. Temp. 517°F
  Vap. Press. 25.8 mm @38°C
  Vap. D. 3.76
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown.
Disaster Control: Dangerous; when exposed to heat or open flame; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

VINYL ETHER

Synonyms: Divinyl ether; divinyl oxide.
Description: Colorless liquid.
Formula: $(CH_2CH)_2O$
Constants: Mol. Wt. 70.1
  B. P. 39°C
  Flash P. −22°F (C.C.)
  Density 0.774 @20°/20°C
  Autoign. Temp. 680°F
  Vap. D. 2.41
Toxicity: Details unknown. See Ethers.
Fire Hazard: Highly dangerous, when exposed to heat or flame.
Underwriters Laboratory Classification: Approximately 100.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Severe in the form of vapor when exposed to

heat or flame.
Explosive Range: 1.85 - 36.5%.
Disaster Control: Highly dangerous, when exposed to heat or open flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

VINYL ETHYL ETHER

Description: Colorless liquid.
Formula: $CH_2CHOC_2H_5$
Constants: Mol. Wt. 72.104
B. P. 35.6°C Flash P. -50°F
Freezing P. -115°C
Density 0.754
Autoign. Temp. 395°F
Vap. Press. 428 mm @20°C
Toxic Hazard Rating:
Acute Local: U
Acute Systemic: Ingestion 2; Inhalation 2
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Highly dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride. See also Ethers.
Explosion Hazard: Details unknown. See Ethers.
Disaster Control: Severe; when heated or exposed to flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

VINYL 2-ETHYLHEXYL ETHER

Description: Liquid.
Formula: $CH_2CHOC_2H_5C_6H_{12}$
Constants: Mol. Wt. 156.3
M. P. -100°C
B. P. 177.5°C
Flash P. 116°F (C.C.)
Density 0.810
Autoign. Temp. 395°F
Vap. D. 5.4
Toxicity: Details unknown. See Ethers.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride. See also Ethers.
Explosion Hazard: Details unknown. See Ethers.
Storage and Handling: Section 7

VINYL FORMATE. See Acrylic Acid.

VINYLIDENE CHLORIDE

Synonym: 1,1-Dichloroethylene.
Description: Colorless, volatile liquid.
Formula: CH_2CCl_2
Constants: Mol. Wt. 97.0
B. P. 31.6°C
Freezing P. -122°C
Flash P. 14°F (O.C.)
Density 1.218 @20°/4°C
Autoign. Temp. Decomposes
Toxicity: Details unknown. See Vinyl Chloride.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate in the form of gas when exposed to heat or flame.
Explosive Range: 7 - 16%.
Disaster Control: Highly dangerous; when heated to decomposition it emits highly toxic fumes; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Inhibited: Flammable liquid; red label.
Coast Guard Classification: Inhibited: Inflammable liquid; red label.

VINYL ISOBUTYL ETHER

Description: Liquid.
Formula: $CH_2CHOC_4H_9$
Constants: Mol. Wt. 100.3
M. P. -132.3°C
B. P. 83.3°C
Flash P. 15°F (O.C.)
Density 0.77
Vap. Press. 68 mm @20°C
Vap. D. 3.45
Toxicity: Details unknown. See also Ethers.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon

tetrachloride. See also Ethers.
Explosion Hazard: Details unknown. See Ethers.
Disaster Control: Dangerous. Keep away from heat or open flame. It can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

VINYL ISOPROPYL ETHER

Description: Liquid.
Formula: $CH_2CHOC_3H_7$
Constants:
Mol. Wt. 86.2
Flash P. -26°F (C.C.)
Autoign. Temp. 522°F
Toxicity: Details unknown. See Ethers.
Fire Hazard: Highly dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride. See also Ethers.
Explosion Hazard: Details unknown. See Ethers.
Disaster Control: Highly dangerous. Keep away from heat or open flame; can react vigorously with oxidizing materials.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

VINYL 2-METHOXYETHYL ETHER

Description: Liquid.
Formula: $CH_2CHOCH_2CH_2OCH_3$
Constants:
Mol. Wt. 102.13
M. P. -82.8°C
B. P. 108.8°C
Flash P. 65°F (O.C.)
Density 0.8967
Vap. D. 3.53
Toxicity: Details unknown. See Ethers.
Fire Hazard: Dangerous, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride. See also Ethers.
Explosion Hazard: Details unknown. See Ethers.
Disaster Control: Dangerous. Keep away from heat and flame.
Ventilation Control (use moderate rate): Section 2
Storage and Handling: Section 7

VINYL METHYL ETHER

Description: Colorless, easily liquefied gas or colorless liquid.
Formula: CH_2CHOCH_3
Constants:
Mol. Wt. 58.1
B. P. 6.0°C
Flash P. Low
Density 0.7500
Toxicity: Details unknown. See Ethers.
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical, carbon tetrachloride or water spray. See also Ethers.
Explosion Hazard: Details unknown. See Ethers.
Disaster Control: Dangerous; shock can shatter the compressed gas container, releasing the contents; when heated, it burns and emits acrid fumes; can react vigorously with oxidizing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Inhibited: Flammable gas; red gas label.
Coast Guard Classification: Inhibited: Inflammable gas; red gas label.

VINYL NONYL ETHER

Description: Liquid.
Formula: $CH_2CHOC_9H_{19}$
Constants: Mol. Wt. 170.3
B. P. 161°F
Density 0.81
Toxicity: Details unknown. See Ethers.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials. See also Ethers.
Explosion Hazard: Details unknown. See Ethers.
Storage and Handling: Section 7

VINYL PYRIDINE

Description: Liquid.
Formula: C_7H_7N
Constants: Mol. Wt. 105.1
B. P. 160°C
Toxicity: Details unknown. See Pyridine.

Caution: An irritant to the skin, eyes and respiratory tract.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of cyanide; can react with oxidizing materials.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

n-VINYL-2-PYRROLIDONE

Description: Colorless liquid.
Formula: C_6H_9NO
Constants:
- Mol. Wt. 111.1
- B. P. 148°C @100 mm
- Freezing P. 13.5°C
- Flash P. 209°F (C.O.C.)
- Density 1.04 @25°C
- Autoign. Temp. 213°F

Toxicity: Unknown
Fire Hazard: Moderate, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Disaster Control: Dangerous, when heated to decomposition it emits highly toxic fumes of oxides of nitrogen; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

VINYL RESINS

Toxic Hazard Rating:
- Acute Local: Allergen 1
- Acute Systemic: U
- Chronic Local: Allergen 1
- Chronic Systemic: U

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Personal Hygiene: Section 3
Storage and Handling: Section 7

VINYL STEARATE

Description: White, waxy solid.
Formula: $H_2CCHCO_2(CH_2)_{16}CH_3$
Constants:
- Mol. Wt. 310.5
- M. P. 28 - 30°C
- B. P. 180°C @2 mm
- Density 0.881 @20°/20°C

Toxicity: Details unknown. See Esters and Alcohols.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

VINYL TOLUENE

Description: Colorless liquid.
Formula: $CH_2CHC_6H_4CH_3$
Constants:
- Mol. Wt. 118.2
- B. P. 170 - 171°C
- Freezing P. −82.5°C
- Flash P. 140°F
- Density
  - Monomer: 0.89 @25°/25°C
  - Polymer: 1.027 @25°/25°C
- Vap. D. 4.08

Toxicity: Details unknown. See Toluene.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

VINYL TRICHLOROSILANE

Description: Fuming liquid.
Formula: $CH_2CHSiCl_3$
Constant:
- Mol. Wt. 162.5

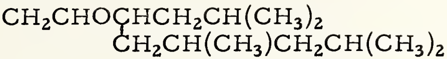
Toxic Hazard Rating:
- Acute Local: Irritant 3; Ingestion 3; Inhalation 3
- Acute Systemic: U
- Chronic Local: U
- Chronic Systemic: U

Fire Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides; will react with water or steam to produce toxic and corrsive fumes.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
- Coast Guard Classification: Inflammable liquid; red label.

VINYL TRIMETHYLNONYL ETHER

Description: Liquid.

Formula:



$CH_2CHOCHCH_2CH(CH_3)_2$
$CH_2CH(CH_3)CH_2CH(CH_3)_2$

Constants: Mol. Wt. 212.36
M. P. -90°C
B. P. 223.5°C
Flash P. 200°F (O. C.)
Density 0.8075 @20°/20°C
Vap. D. 7.33

Toxicity: Details unknown. See Ethers.

Fire Hazard: Moderate, when exposed to heat or flame; it can react with oxidizing materials.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Storage and Handling: Section 7

VULCAN COAL POWDERS. See Explosives, High.

W

WALL PLASTER

Toxic Hazard Rating:
- Acute Local: Irritant 1; Allergen 1; Inhalation 1
- Acute Systemic: U
- Chronic Local: Allergen 1
- Chronic Systemic: U

Antidote: In spite of its slight adverse effects, plaster may be used in an emergency to neutralize a strong acid or poison taken internally (Section 1).

Ventilation Control (use normal rate): Section 2

Personal Hygiene: Section 3

WARFARIN

Synonym: (3-(alpha-acetonylbenzene)-4-hydroxycoumarin.

Description: Colorless, odorless, tasteless crystals.

Constant:
M. P. 161°C

Toxicology: Warfarin has two actions—inhibition of prothrombin formation and capillary damage. There is evidence that these two actions are produced by the two moieties of the molecule. Thus, 4-hydroxycoumarin inhibits the formation of prothrombin and reduces the clotting power of the blood, while there is some evidence benzalacetone produces capillary damage and leads to bleeding upon the very slightest trauma. Significantly enough, vitamin K has an antidotal action against both actions of warfarin up to a certain point.

The action of warfarin is similar to that of the common drug Dicoumarol, except that capillary damage (the so-called "toxic factor") is greatly increased.

Dangerous Acute and Chronic Dose in Man: Information on the toxicity of warfarin to man is available. Serious illness was induced by ingesting 1.7 mg of warfarin per kg per day for 6 consecutive days with suicidal intent. This would correspond to eating almost 1 pound of warfarin bait (0.025 percent warfarin) each day for 6 days. All signs and symptoms were caused by hemorrhage and, following multiple small transfusions and massive doses of vitamin K, recovery was complete.

Data from animal experiments suggest that a single dose would be harmless. The rat is specifically susceptible to warfarin, yet mortalities are highly irregular and may be low following single doses of 50, 100, or even 150 mg/kg. To obtain a dose of 50 mg/kg the average 150-pound man would have to eat 0.7 kg or 1.5 pounds of the warfarin concentrate available on the market, although the amount of active ingredient would be only 3.5 g. To obtain the same dose with the strongest bait recommended, the same man would have to eat 14 kg or 30 pounds of the rat bait.

However, with repeated daily doses, the effective toxicity of the compound is greatly increased. For example, five daily doses of 1.0 mg/kg each (a total of 5.0 mg/kg) is sufficient to kill all rats which eat it. There is considerable species difference in susceptibility. For example, chickens may be raised to maturity on an adequate growing mash containing an effective rodenticidal concentration of warfarin.

The possibility of human poisoning by warfarin must be kept in mind, although the safety factors make it appear unlikely that poisoning will occur except with suicidal intent or as a result of gross carelessness and ignorance.

Signs and Symptoms of Poisoning in Man: The initial symptoms in an attempted suicide using warfarin were back pain and abdominal pain. The onset occurred the first day after the sixth daily dose. A day after onset vomiting and attacks of nose bleeding occurred. On the second day of illness, when admitted to the hospital, the patient was observed to have a generalized petechial rash. The prothrombin time was greatly prolonged. The coagulation time was definitely increased by the Lee-White method and slightly increased by the capillary tube method. Bleeding time was normal. Urine was normal in appearance but contained many red cells on microscopic examination.

Treatment: After blood has been taken for prothrombin and other differential diagnostic tests, a blood transfusion should be given at once if there is reasonable assurance that warfarin poisoning has occurred, irrespective of whether or not signs and symptoms are present. Vitamin K in a dose of 65 mg (gr. 1) repeated three times on the first day of treatment is suggested irrespective of symptoms. Smaller doses should be continued until the prothrombin time has reached normal. In a more seriously ill patient, small transfusions of carefully matched whole blood should be given daily until the patient has returned to normal. Should it ever be necessary to treat a patient in shock from blood loss resulting from warfarin poisoning, frequent small transfusions and a complete consideration of the blood chemistry would be in order. Any large hematomata should be the subject of surgical consultation, but any surgical action should be taken only after the clotting power of the blood is restored to normal.

Personnel Protection: Section 3

Personal Hygiene: Section 3

Shipping Regulations: Section 11.
MCA warning label.

WASTE PAPER, WET

Fire Hazard: Moderate, when exposed to heat or by spontaneous chemical reaction; can react with oxidizing materials (Section 6).

Storage and Handling: Section 7

Shipping Regulations: Section 7
I. C. C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

WASTE TEXTILE, WET

Fire Hazard: Moderate, when exposed to heat or by spontaneous chemical reaction; can react with oxidizing materials (Section 6).

Storage and Handling: Section 7

Shipping Regulations: Section 11.
I. C. C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

WASTE WOOL, WET

Fire Hazard: Moderate, when exposed to heat or flame or by spontaneous chemical reaction; can react with oxidizing materials (Section 6).

Storage and Handling: Section 7

Shipping Regulations: Section 11.
I. C. C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

WATER GAS. See Carbon Monoxide and Hydrogen (hazardous components).

WATER TREATING COMPOUND, LIQUID. See Acids, N. O. S. or Alkalis, N. O. S.

Shipping Regulations: Section 11.
I. C. C. Classification: Corrosive liquid; white label.
Coast Guard Classification: Corrosive liquid; white label.

WELDING FUMES

Toxic Hazard Rating:
Acute Local: Irritant 2; Inhalation 2
Acute Systemic: Irritant 1; Inhalation 1
Chronic Systemic: U

MAC: ACGIH (accepted); 25 parts per million in air.

Toxicology: When welding is done on

a surface coated with cadmium, toxic fumes of cadmium can be evolved. When zinc-coated surfaces are welded, toxic quantities of zinc oxide may be liberated. When painted surfaces are welded, lead or other pigment fumes may be liberated. And when fluoride fluxes are used in welding, very toxic fluoride fumes are evolved. When oily surfaces are welded, offensive and toxic fumes can be liberated, and when the welding torch is improperly ignited, carbon monoxide which is very toxic may be evolved. Also, oxides of nitrogen may be formed. It is therefore considered hazardous to inhale excessive amounts of welding fumes. It is also possible to inhale sufficient quantities of iron oxide from welding to cause siderosis which is not, however, considered a serious condition.

Safety goggles are required to protect against spatter. Light-filtering goggles are required to shield the eyes against arc.

Ventilation Control (use moderate rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3

WET NITROCELLULOSE (COLLODION COTTON) 20% WATER. See Nitrocellulose (Collodion Cotton).
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

WET NITROCELLULOSE (COLLODION COTTON) 30% ALCOHOL (OR SOLVENT). See Nitrocellulose (Collodion Cotton).
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

WET NITROCELLULOSE, COLLOIDED, GRANULAR OR FLAKE - 20% ALCOHOL (OR SOLVENT) See Nitrocellulose.
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

WET NITROCELLULOSE, COLLOIDED, GRANULAR OR FLAKE - 20% WATER. See Nitrocellulose.
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

WET NITROGUANIDINE - 20% WATER. See Nitroguanidine.
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

WET NITROSTARCH - 20% WATER. See Nitrostarch.
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

WET NITROSTARCH - 30% ALCOHOL (OR SOLVENT). See Nitrostarch.
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable liquid; red label.
Coast Guard Classification: Inflammable liquid; red label.

WHALE OIL
Constants: Density 0.925
Flash P. 446°F (C. C.)
Autoign. Temp. 800°F
Toxicity: Details unknown. Probably very low.
Fire Hazard: Slight, when exposed to heat or flame.
Spontaneous Heating: Yes
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

WHEAT OIL
Toxic Hazard Rating:
Acute Local: Allergen 1
Acute Systemic: 0
Chronic Local: Allergen 1

Chronic Systemic: 0
Disaster Control: Slightly dangerous; when heated, it emits acrid fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

WHISKY
Description: Light to deep-amber liquid; characteristic odor and taste.
Composition: Approx. 50% ethyl alcohol (by vol.) + acetic acid and ethyl acetate.
Constants:
Flash P. 82°F (C.C.)
Density 0.935 - 0.923 @25°C
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Ingestion 2
Chronic Local: 0
Chronic Systemic: Ingestion 1
Fire Hazard: Moderate, when exposed to heat or flame; can react vigorously with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

WHITE LEAD. See Lead Compounds.

WHITE SPIRIT. See Turpentine Substitute.

WINES, HIGH
Description: Light golden to amber color, aromatic, alcoholic liquids.
Constant:
Flash P. 60 - 80°F
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Ingestion 1
Chronic Local: 0
Chronic Systemic: Ingestion 1
Fire Hazard: Dangerous; when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

WINES (SHERRY AND PORT)
Description: Light golden to amber color, aromatic, alcoholic liquids.
Constant: Flash P. 129°F
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Ingestion 1
Chronic Local: 0
Chronic Systemic: Ingestion 1
Fire Hazard: Moderate when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Storage and Handling: Section 7

WINTERGREEN OIL. See Methyl Salicylate.

WITCH HAZEL
Synonyms: Hamamelis; tobacco wood.
Toxic Hazard Rating:
Acute Local: Irritant 1; Ingestion 1
Acute Systemic: Ingestion 1
Chronic Local: U
Chronic Systemic: U
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Unknown
Personal Hygiene: Section 3
Storage and Handling: Section 7

WOOD GAS. See Carbon Monoxide.

WOOD TAR ACID
Toxicity: Details unknown; a fungicide, herbicide and insecticide.
Fire Hazard: Unknown
Disaster Control: Slightly dangerous; when heated it emits smoke.
Storage and Handling: Section 7

WOOD TAR OIL
Toxicity: Details unknown; a fungicide and insecticide.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

WOOL AND WOOL WASTES
Toxic Hazard Rating:
Acute Local: Allergen 1;

Inhalation 1
Acute Systemic: 0
Chronic Local: Allergen 1; Inhalation 1
Chronic Systemic: 0
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Spontaneous Heating: Yes, particularly when wet.
Personal Hygiene: Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11
Coast Guard Classification (See Cotton Waste): Hazardous; (Wet, see Rags, Wet) Inflammable solid; yellow label.

WORMWOOD OIL

Toxic Hazard Rating:
Acute Local: Irritant 1
Acute Systemic: Ingestion 2
Chronic Local: U
Chronic Systemic: Ingestion 2
Caution: This is the essence of absinthe, prolonged use of which can lead to mental deterioration.
Personal Hygiene: Section 3
Storage and Handling: Section 7

X

XANTHOGEN DISULFIDE
Toxicity: Details unknown. See Sulfides.
Fire Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

XENON
Description: Colorless, inert gas.
Formula: Xe
Constants:
At. Wt. 131.30
M. P. −112°C
B. P. −107.1°C
Density 5.851 grams per liter; liquid: 3.06 @ −109°C
Toxic Hazard Rating:
Acute Local: 0
Acute Systemic: Inhalation 1
Chronic Local: 0
Chronic Systemic: 0
Caution: A simple asphyxiant. For a discussion of toxic effects see Argon.
Radiation Hazard (Section 5): Artificial isotope Xe^{133}, half-life: 5.3 days; emits beta particles of 0.33 mev and gamma rays of 0.08 mev. The permissible levels are: In body: 300 microcuries; in air: 4×10^{-6} microcurie per milliliter; in water: 4×10^{-3} microcurie per milliliter.

Xe^{133} is an isotope produced by neutron irradiation in aircooled nuclear reactors.

Artificial isotope Xe^{135}, half-life: 9.2 hours; emits beta particles of 0.95 mev and gamma rays of 0.25 mev. The permissible levels are: In body: 100 microcuries; in air: 2×10^{-6} microcurie per milliliter; in water: 1×10^{-3} microcurie per milliliter. Xe^{135} is an isotope produced by neutron irradiation in aircooled nuclear reactors.
Disaster Control: Moderately dangerous; shock can shatter the compressed gas container with explosive force, releasing contents.
Storage and Handling: Section 7

X-RAY FILM (NITROCELLULOSE BASE)
Toxicity: See Nitrates.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

X-RAY FILM SCRAP (NITROCELLULOSE BASE)
Toxicity: See Nitrates.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Inflammable solid; yellow label.

X-RAY FILM SCRAP (NITROCELLULOSE BASE) OTHER THAN SAMPLES. See X-Ray Film (Nitrocellulose Base).
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable solid; yellow label (not accepted).

X-RAY FILM, SCRAP (NITROCELLULOSE BASE), SAMPLES OF
Toxicity: See Nitrates.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label.

X-RAY FILM, SLOW BURNING

Fire Hazard: Moderate when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition they emit highly toxic fumes of oxides of nitrogen; can react vigorously with oxidizing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  Coast Guard Classification: No restriction.

X-RAYS

Description: Highly penetrating electromagnetic radiation produced by electrical means.
Radiation Hazard: See Gamma Rays and Section 5

m-XYLENE

Synonym: m-Xylol.
Description: Colorless liquid.
Formula: $C_6H_4(CH_3)_2$
Constants:
  Mol. Wt. 106.2
  M. P. −47.9°C
  B. P. 139°C
  Flash P. 77°F
  Density 0.864 @20°/4°C
  Vap. Press. 10 mm @28.3°C
  Vap. D. 3.66
Toxic Hazard Rating:
  Acute Local: Irritant 1
  Acute Systemic: Inhalation 1
  Chronic Local: Irritant 1
  Chronic Systemic: Inhalation 1; Skin Absorption 1
MAC: ACGIH (accepted); 200 parts per million in air; 868 milligrams per cubic meter of air.
Fire Hazard: Dangerous, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate in the form of vapor when exposed to heat or flame.
Explosive Range: 1.1 - 7.0%.
Disaster Control: Dangerous. Keep away from open flame.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene Section 3
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Combustible liquid; inflammable liquid, red label.
  MCA warning label

o-XYLENE

Synonym: o-Xylol.
Description: Colorless liquid.
Formula: $C_6H_4(CH_3)_2$
Constants: Mol. Wt. 106.2
  B. P. 144.4°C
  Freezing P. −25.5°C
  Flash P. 115°F (T.O.C.)
  Density 0.880 @20°/4°C
  Vap. Press. 10 mm @32.1°C
  Vap. D. 3.66
Toxicity: See m-Xylene.
MAC: ACGIH (accepted); 200 parts per million in air; 868 milligrams per cubic meter of air.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
Underwriters Laboratory Classification: 40 - 45.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Slight, in the form of vapor when exposed to heat or flame.
Explosive Range: 1.1 - 7.0%
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable liquid; red label.
  Coast Guard Classification: Combustible liquid; inflammable liquid, red label.
  MCA warning label

p-XYLENE

Synonym: p-Xylol.
Description: Clear liquid.
Formula: $C_6H_4(CH_3)_2$
Constants: Mol. Wt. 106.2
  B. P. 138.3°C
  Freezing P. 13.2°C
  Flash P. 103°F (T.O.C.)
  Density 0.8611 @20°/4°C
  Vap. Press. 10 mm@ 27.3°C
  Vap. D. 3.66
Toxicity: See m-Xylene.

MAC: ACGIH (accepted); 200 parts per million in air; 868 milligrams per cubic meter of air.
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Moderate in the form of vapor when exposed to heat or flame.
Explosive Range: 1.1 - 7.0%.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7
Shipping Regulations: Section 11.
 I.C.C. Classification: Flammable liquid; red label.
 Coast Guard Classification: Combustible liquid; inflammable liquid, red label.
 MCA warning label.

XYLENE HEXAFLUORIDE

Synonym: Bis(trifluoromethyl) benzene.
Description: Clear, water-white liquid.
Formula: $C_6H_4(CF_3)_2$
Constants:
 Mol. Wt. 214.11
 M. P. −40 to −50°C
 B. P. 115°C
 Density 1.395 @20°/15.5°C
Toxicity: Details unknown. See Xylene and Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

XYLENES (MIXED m- and p-ISOMERS)

Description: A clear liquid.
Constants:
 B. P. 138.5°C
 Flash P. 100°F (T.O.C.)
 Density 0.864 @20°/4°C
 Vap. Press. 6.72 mm @21°C
Toxicity: Unknown
Fire Hazard: Moderate, in the presence of heat or flame; can react with oxidizing materials.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

XYLENE SUBSTITUTES

Description: Liquid.
Constants:
 Flash P. 45°F
 Density 0.760
Toxicity: Unknown
Fire Hazard: Dangerous, when exposed to heat or flame.
To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous. Keep away from heat and flame; can react with oxidizing materials.
Storage and Handling: Section 7

3,5-XYLENOL

Synonyms: 3,5-Dimethyl phenol; 1-hydroxy-3,5-dimethyl benzene; 5-hydroxy-1,3-dimethyl benzene.
Description: White crystals.
Formula: $(CH_3)_2C_6H_3OH$
Constants:
 Mol. Wt. 122.16
 M. P. 68°C
 B. P. 219.5°C
 Density 1.0362
 Vap. Press. 1 mm @62.0°C
Toxicity: See Xylene.
Fire Hazard: Slight, when exposed to heat or flame.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

XYLIDENE

Synonym: Aminodimethylbenzene.
Description: Usually liquid (except for o-4-xylidene).
Formula: $(CH_3)_2C_6H_3NH_2$
Constants:
 Mol. Wt. 121.2
 B. P. 213 - 226°C
 Flash P. 206°F (C.C.)
 Density 0.97 - 0.99
 Vap. D. 4.17
Toxic Hazard Rating:
 Acute Local: U
 Acute Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
 Chronic Local: U
 Chronic Systemic: Ingestion 3; Inhalation 3; Skin Absorption 3
Toxicology: This material, which so closely resembles aniline in its toxic effects, is actually twice as toxic as aniline, based on the determination of the LD50 for

mice by inhalation. It can cause injury to the blood and the liver. It does not necessarily give any alarm or warning, such as cyanosis, headache, and dizziness which characterizes aniline poisoning. Thus it may be considered a more insidious poison than aniline, and severe and possibly fatal intoxication may come about through skin absorption. From animal experimentation it has been further found that the minimum lethal dose for rabbits is 0.28 g/kg of body weight, and that the lethal dose intravenously is 240 mg/kg of body weight for rabbits. The signs of intoxication in animals are loss of weight, dyspnea, prostration, albuminuria, and occasional terminal convulsions. This compound penetrates the intact skin of rabbits in sufficient quantity to cause cyanosis and death. There are no local effects upon the skin. The application of 3.3 grams or more of this material per kilogram of body weight on the intact skin of a rabbit for an hour or more always caused fatal results. A 2% solution of this material caused no harm to 3 rabbits in the course of 50 periods of cutaneous contact.

Treatment and Antidotes: In case of exposure, contact the medical department immediately. When it splashes or spills upon the person, the area of contact should be washed with copious quantities of warm water aided by soap. Remove all contaminated clothing and if possible wash the area affected under a deluge-type of shower. Protective clothing should be washed before reuse. This material must not be used without adequate ventilation as well as personal protective equipment. See also Aniline. Personnel engaged working with it should do so under the direct supervision of a medical department.

Fire Hazard: Moderate when exposed to heat or flame.

To Fight Fire: Foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).

Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes; can react vigorously with oxidizing materials.

Ventilation Control (use moderate rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

First Aid: Section 1

Storage and Handling: Section 7

Shipping Regulations: Section 11.
  Coast Guard Classification:
    Poison B; poison label.
  MCA warning label

XYLOLS. See Xylenes - o, m, p.

m-XYLYL BROMIDE

Description: Colorless liquid.

Formula: C_8H_9Br

Constants:
  Mol. Wt. 185.1
  B. P. 213°C
  Density 1.371 @23°C

Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U

Fire Hazard: Moderate, when exposed to heat or flame.

Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of bromine and bromine compounds; can react vigorously with oxidizing materials.

Ventilation Control (use normal rate): Section 2

Personnel Protection: Section 3

Personal Hygiene: Section 3

Storage and Handling: Section 7

Shipping Regulations: Section 11.
  I.C.C. Classification: Poison C; tear gas label.
  Coast Guard Classification:
    Poison C; tear gas label.

o-XYLYL BROMIDE

Synonym: o-Methyl benzyl bromide.

Description: Crystals.

Formula: C_8H_9Br

Constants:
  Mol. Wt. 185.1
  M. P. 21°C
  B. P. 217°C
  Density 1.381

Toxicity: See m-Xylyl Bromide.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of bromine and bromine compounds.
Storage and Handling: Section 7

p-XYLYL BROMIDE

Description: White crystals.
Formula: C_8H_9Br
Constants:
  Mol. Wt. 185.1
  M. P. 36°C
  B. P. 220°C @740 mm
  Density 1.324
Toxicity: See m-Xylyl Bromide.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Disaster Control: See m-Xylyl Bromide.
Storage and Handling: Section 7

m-XYLYL CHLORIDE

Description: Colorless liquid.
Formula: $CH_3C_6H_4CH_2Cl$
Constants:
  Mol. Wt. 140.61
  B. P. 196°C
  Density 1.064
Toxic Hazard Rating:
  Acute Local: Irritant 3; Ingestion 3; Inhalation 3
  Acute Systemic: U
  Chronic Local: U
  Chronic Systemic: U
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides.
Ventilation Control (use normal rate): Section 2
Personnel Protection: Section 3
Personal Hygiene: Section 3
Storage and Handling: Section 7

o-XYLYL CHLORIDE

Synonym: o-Methyl benzyl chloride.
Description: Colorless liquid.
Formula: C_8H_9Cl
Constants:
  Mol. Wt. 140.6
  B. P. 195 - 199°C
Toxicity: See m-Xylyl Chloride.
Disaster Control: See m-Xylyl Chloride.
Storage and Handling: Section 7

p-XYLYL CHLORIDE

Description: Fuming liquid, odor.
Formula: C_8H_9Cl
Constants: Mol. Wt. 140.6
  B. P. 200 - 202°C
Toxicity: See m-Xylyl Chloride.
Fire Hazard: See m-Xylyl Chloride.
Disaster Control: See m-Xylyl Chloride.
Storage and Handling: Section 7

Y

YELLOW PRUSSIATE OF SODA.

See Sodium Ferrocyanide.

YEW

Description: A wood.
Toxic Hazard Rating:
  Acute Local: Irritant 1; Allergen 1; Inhalation 1
  Acute Systemic: U
  Chronic Local: Allergen 1
  Chronic Systemic: U
Fire Hazard: Moderate, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Explosion Hazard: Slight, in the form of dust when exposed to flame.
Personal Hygiene: Section 3
Storage and Handling: Section 7

YOHIMBENE

Synonym: Isomer of yohimbine.
Description: Light-sensitive crystals.
Formula: $C_{21}H_{26}N_2O_3$
Constants:
  Mol. Wt. 354.2
  M. P. 278°C (decomp.)
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 3
  Chronic Local: U
  Chronic Systemic: U
Caution: An alkaloid poison. See Yohimbine.
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

YOHIMBINE

Synonyms: Corynine; aphrodine; quebrachine.
Description: Colorless needles from water and alcohol.
Formula: $C_{21}H_{26}N_2O_3$
Constants:
  Mol. Wt. 354.44
  M. P. 235°C
Toxic Hazard Rating:
  Acute Local: U
  Acute Systemic: Ingestion 2
  Chronic Local: U
  Chronic Systemic: U
Toxicology: This material is a poison. Cases of poisoning have occurred from its use as an aphrodisiac. Upon local application, it produces anesthesia. However, absorption of it can give rise to toxic symptoms, such as salivation, increased respiration, and repeated defecation. With reference to the circulatory system, there may be a fall in blood pressure and sometimes myocardial damage, involving particularly the conduction system of the heart, with a resultant decrease in the efficiency of the heart.
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes.
Personal Hygiene: Section 3
Storage and Handling: Section 7

YOHIMBINE HYDROCHLORIDE

See Yohimbine.

YITTERBIUM

Formula: Yb
Constants:
  Mol. Wt. 173.04
  M. P. 1800°C
Toxicity: Unknown
Radiation Hazard (Section 5): Artificial isotope Yb^{175}, half-life: 4.2 days; emits beta particles between 0.13 - 0.48 mev and gamma rays of 0.35 mev.
Fire Hazard: Moderate, in the form of dust when exposed to heat or flame (Section 6).

YTTERBIUM SELENATE

Description: Hexagonal plates.
Formula: $Yb_2(SeO_4)_3 \cdot 8H_2O$
Constants:
Mol. Wt. 919.1
Density 3.30
Toxicity: See Selenium.
Disaster Control: See Selenium.
Storage and Handling: Section 7

YTTERBIUM SELENITE

Formula: $Yb_2(SeO_3)_3$
Constant:
Mol. Wt. 727.0
Toxicity: See Selenium.
Disaster Control: See Selenium.
Storage and Handling: Section 7

YTTRIUM

Description: Hexagonal, gray-black metal.
Formula: Y
Constants:
Mol. Wt. 88.9
M. P. 1490 - 1250°C
B. P. 2500°C
Density 5.51
Toxicity: Unknown
Radiation Hazard (Section 5): Artificial isotope Y^{90}, half-life: 63 hours; emits beta particles of 2.2 mev. The permissible levels are: In body: 1 microcurie; in air: 2×10^{-10} microcurie per milliliter; in water: 8×10^{-7} microcurie per milliliter.

Y^{90} exists in equilibrium with its parent, Sr^{90}. The hazard rating and permissible levels are given for the equilibrium mixture. See Sr^{90}. Hazard Rating, Class III (National Bureau of Standards Handbook No. 42).

Artificial isotope Y^{91}, half-life: 59 days; emits beta particles of 1.5 mev. The permissible levels are: In body: 15 microcuries; in air: 4×10^{-8} microcurie per milliliter; in water: 0.2 microcurie per milliliter. Hazard Rating, Class III (National Bureau of Standards Handbook No. 42).

Fire Hazard: Moderate, in the form of dust when exposed to heat or flame (Section 6).

YTTRIUM BROMATE

Description: Hexagonal, prismatic crystals.
Formula: $Y(BrO_3)_3 \cdot 9H_2O$
Constants:
Mol. Wt. 634.8
M. P. 74°C
$-6H_2O$ @100°C
Toxicity: See Bromates.
Fire Hazard: See Bromates.
Disaster Control: See Bromates.
Storage and Handling: Section 7

YTTRIUM BROMIDE

Description: Deliquescent crystals.
Formula: YBr_3
Constant:
Mol. Wt. 328.7
Toxicity: See Bromides.
Disaster Control: See Bromides.
Storage and Handling: Section 7

YTTRIUM FLUORIDE

Description: Gelatinous material.
Formula: $YF_3 \cdot \frac{1}{2}H_2O$
Constant:
Mol. Wt. 154.9
Toxicity: See Fluorides.
Disaster Control: See Florides.
Storage and Handling: Section 7

YTTRIUM NITRATE

Description: Reddish-white prisms.
Formula: $Y(NO)_3 \cdot 4H_2O$
Constants:
Mol. Wt. 347.0
Density 2.682
Toxicity: See Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7

YTTRIUM OXIDE

Synonym: Yttria.
Description White powder.
Formula: Y_2O_3
Constants:
Mol. Wt. 225.8
Density 4.84
Toxicity: Unknown

YTTRIUM SULFIDE

Description: Yellow-gray powder.
Formula: Y_2S_3
Constant:
Mol. Wt. 274.04
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

Z

ZINC

Description: Hexagonal, bluish-white metal.
Formula: Zn
Constants:
At. Wt. 65.38
M. P. 419.4°C
B. P. 907°C
Density 7.14
Vap. Press. 1 mm @487°C
Toxicity: See Zinc Compounds.
Radiation Hazard (Section 5): Artificial isotope Zn^{65}, half-life: 250 days; emits gamma rays of 1.1 mev and positron particles of 0.32 mev. The permissible levels are: In body: 430 microcuries; in air: 2×10^{-6} microcurie per milliliter; in water: 6×10^{-2} microcurie per milliliter.
Artificial isotope Zn^{72}, half-life: 49 hours; emits gamma rays and electron particles of 0.3 mev.
Fire Hazard: Moderate in the form of dust when exposed to heat or flame.
Spontaneous Heating: No
To Fight Fire: Special mixtures of dry chemical (Section 6).
Explosion Hazard: Slight, in the form of dust when exposed to flame. See also Powdered Metals.

ZINC ACETATE

Description: Monoclinic crystals.
Formula: $Zn(C_2H_3O_2)_2$
Constants:
Mol. Wt. 183.47
M. P. 242°C
B. P. Sublimes in vacuum
Density 1.84
Toxicity: See Zinc Compounds.

ZINC AMIDE

Description: Amorphous, white powder.
Formula: $Zn(NH_2)_2$
Constants:
Mol. Wt. 97.43
M. P. Decomposes @200°C
Density 2.13 @25°C
Toxicity: See Zinc Compounds.
Fire Hazard: Unknown
Explosion Hazard: Unknown
Disaster Control: Unknown

ZINC AMMONIUM NITRITE

Description: Solid.
Formula: $ZnNH_4(NO_2)_3$
Constant: Mol. Wt. 221.5
Toxicity: See Nitrites and Zinc Compounds.
Fire Hazard: Moderate, by spontaneous chemical reaction. A powerful oxidizing agent.
Explosion Hazard: Unknown
Disaster Control: See Nitrites.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

ZINC ARSENATE

Description: White, odorless powder.
Composition: Variable; approximately $5ZnO$, $2As_2O_5$, $4H_2O$
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.

ZINC o-ARSENATE

Description: Monoclinic crystals.
Formula: $Zn_3(AsO_4)_2 \cdot 8H_2O$
Constants: Mol. Wt. 618.09
M. P. Decomposes @100°C
Density 3.309 @15°C
Toxicity: See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7

ZINC ARSENIDE
Description: Cubic crystals.
Formula: Zn_3As_2
Constant:
Mol. Wt. 345.96
Toxicity: Highly toxic. See Arsenic Compounds.
Fire Hazard: Moderate; it can evolve arsine upon contact with moisture or acids. See also Arsine.
Explosion Hazard: Moderate; it can evolve arsine upon contact with moisture or acid. See also Arsine.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of arsenic.
Ventilation Control (use normal rate): Section 2
Storage and Handling: Section 7

ZINC ARSENITE. See Zinc m-Arsenite.

ZINC m-ARSENITE
Synonyms: ZMA; zinc arsenite.
Description: White powder.
Formula: $Zn(AsO_2)_2$
Constant: Mol. Wt. 279.2
Toxicity: Highly toxic. A wood preservative, insecticide. See Arsenic Compounds.
Disaster Control: See Arsenic Compounds.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Poison B; poison label.
Coast Guard Classification: Poison B; poison label.
MCA warning label.

ZINC BORATE
Description: White, amorphous powder or triclinic crystals.
Formula: $3ZnO \cdot 2B_2O_3$
Constants: Mol. Wt. 383.42
M. P. 980°C
Density (amor.) 3.64; (crystal) 4.22
Toxicity: A fungicide. See Boron and Zinc Compounds.

ZINC BROMATE
Description: White, deliquescent powder.
Formula: $Zn(BrO_3)_2 \cdot 6H_2O$
Constants:
Mol. Wt. 429.3
M. P. 100°C
B. P. $-6H_2O$ @200°C
Density 2.566
Toxicity: See Bromates and Zinc Compounds.
Fire Hazard: See Bromates.
Explosion Hazard: See Bromates.
Disaster Control: See Bromates.
Storage and Handling: Section 7

ZINC BROMIDE
Description: Rhombic, colorless, hygroscopic crystals.
Formula: $ZnBr_2$
Constants:
Mol. Wt. 225.2
M. P. 394°C
B. P. 650°C
Density 4.219 @4°C
Toxicity: See Bromides and Zinc Compounds.

ZINC CARBONATE
Description: White crystalline powder.
Formula: $ZnCO_3$
Constants: Mol. Wt. 125.4
M. P. $-CO_2$ @300°C
Density 4.42 to 4.45
Toxicity: See Zinc Compounds.

ZINC CHLORATE
Description: Colorless, very deliquescent crystals.
Formula: $Zn(ClO_3)_2 \cdot 4H_2O$
Constants:
Mol. Wt. 304.36
M. P. Decomposes @60°C
B. P. Decomposes
Density 2.15
Toxicity: See Chlorates and Zinc Compounds.
Fire Hazard: See Chlorates.
Explosion Hazard: See Chlorates.
Disaster Control: See Chlorates.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I. C. C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

ZINC CHLORIDE
Synonym: Butter of zinc.
Description: Cubic, white, deliquescent crystals.

Formula: $ZnCl_2$
Constants:
Mol. Wt. 136.30
M. P. 262°C
B. P. 732°C
Density 2.91 @25°C
Vap. Press. 1 mm @428°C
Toxicity: See Zinc Compounds and Chlorides.
Shipping Regulations: Section 11. MCA warning label

ZINC CHLORIDE, CHROMATED

Description: Solid.
Toxicity: See Chromium Compounds.
Fire Hazard: Slight, as an oxidizing agent, reacts with reducing agents.
Storage and Handling: Section 7

ZINC 5-CHLORO-2-MERCAPTOBENZOTHIAZOLE

Toxicity: Details unknown; a fungicide. See Zinc Compounds.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of chlorides and oxides of sulfur.
Storage and Handling: Section 7

ZINC CHROMATE

Description: Lemon-yellow prisms.
Formula: $ZnCrO_4$
Constant:
Mol. Wt. 181.4
Toxicity: See Chromium Compounds.
Fire Hazard: Moderate, by chemical reaction. An oxidizing agent (Section 6).

ZINC COMPOUNDS

Toxicity: Vairable, generally of low toxicity:
Toxicology: Zinc is not inherently a toxic element. However, when heated, it evolves a fume of zinc oxide which, when inhaled fresh, can cause a disease known as "brass founders' ague," or "brass chills." It is possible for people to become immune to it. However, this immunity can be broken by cessation of exposure of only a few days. Zinc oxide dust which is not freshly formed is virtually innocuous. There is no cumulative effect to the inhalation of zinc fumes. Fatalities, however, have resulted from lung damage caused by the inhalation of high concentrations of zinc chloride fumes. Soluble salts of zinc have a harsh metallic taste; small doses can cause nausea and vomiting, while larger doses cause violent vomiting and purging. So far as can be determined, the continued administration of zinc salts in small doses has no effect in man except those of disordered digestion and constipation. Exposure to zinc chloride fumes can cause damage to the mucous membrane of the nasopharnyx and respiratory tract and give rise to a pale gray cyanosis.

It has been stated that zinc oxide dust can block the ducts of the sebaceous glands and give rise to a papular, pustular eczema in men engaged in packing this compound into barrels. Sensitivity to zinc oxide in man is extremely rare. Zinc chloride, because of its caustic action, can cause ulceration of the fingers, hands and forearms of those who use it as a flux in soldering. This condition has even been observed in men who handle railway ties which have been impregnated with this material. It is the opinion of some who work with it that it is carcinogenic.

Treatment and Antidotes: Personnel exposed to zinc chloride fumes should immediately wash the area of contact with copious quantities of warm water and soap. Remove all contaminated clothing at once and if the area of contact is large, subject patient to a deluge-type of shower as quickly as possible. If the eyes are involved in exposure to zinc chloride fumes, they should be irrigated for at least 15 minutes with warm water.
Ventilation Control (use normal rate): Section 2
Personal Hygiene: Section 3
Storage and Handling: Section 7

ZINC CYANIDE

Description: Rhombic, colorless crystals.
Formula: $Zn(CN)_2$

Constants: Mol. Wt. 117.4
M. P. Decomposes @800°C
Toxicity: Highly toxic, See Cyanides and Zinc Compounds.
Fire Hazard: See Cyanides.
Explosion Hazard: See Cyanides.
Disaster Control: See Cyanides.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: See Section 11, §73.370
Coast Guard Classification: Poison B; poison label.

ZINC DIBUTYLDITHIOCARBAMATE

Description: White powder.
Formula: $Zn[SC(S)N(C_4H_9)_2]_2$
Constants: Mol. Wt. 474.2
M. P. 104 - 108°C
Density 1.24 @20°/20°C
Toxicity: See Zinc Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

ZINC DICHROMATE

Description: Orange-yellow powder; reddish-brown, hygroscopic crystals.
Formula: $ZnCr_2O_7 \cdot 3H_2O$
Constant: Mol. Wt. 335.45
Toxicity: See Chromium Compounds.
Fire Hazard: Moderate, by chemical reaction. It can react with reducing materials. A powerful oxidizing agent (Section 6).
Storage and Handling: Section 7

ZINC DIETHYL

Synonym: Zinc ethyl.
Description: Liquid.
Formula: $Zn(C_2H_5)_2$
Constants: Mol. Wt. 123.5
M. P. -28°C
B. P. 118°C
Density 1.2065 @20°/4°C
Toxicity: See Zinc Compounds.
Fire Hazard: Dangerous, by spontaneous chemical reaction. Spontaneously flammable in air.
Explosion Hazard: Unknown
Disaster Control: Dangerous fire hazard; can react vigorously with oxidizing materials.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Flammable liquid; red label (not accepted).
Coast Guard Classification: Inflammable liquid; red label.

ZINC DIETHYLDITHIOCARBAMATE

Description: White powder.
Formula: $Zn[SC(S)N(C_2H_5)_2]_2$
Constants: Mol. Wt. 361.9
Density 1.47 @20°/20°C
Toxicity: See Zinc Compounds.
Toxicology: This material is very irritating to the eyes, nose and throat. Several hours after the material may have gotten into the eyes, it causes an unbearable pain. A seed disinfectant, fungicide, rubber accelerator.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of sulfur and cyanides.
Storage and Handling: Section 7

ZINC DIMETHYL

Description: Mobile liquid.
Formula: $Zn(CH_3)_2$
Constants: Mol. Wt. 95.5
M. P. -40°C
B. P. 46°C
Density 1.386 @10.5°/4°C
Toxicity: See Zinc Compounds.
Fire Hazard: Dangerous, by chemical reaction. Spontaneously flammable in air (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition it burns and emits toxic fumes of zinc compounds; can react with oxidizing materials.
Storage and Handling; Section 7

ZINC DIMETHYLDITHIOCARBAMATE

Synonyms: Ziram.
Description: White powder.
Formula: $Zn[SC(S)N(CH_3)_2]_2$
Constants: Mol. Wt. 306.0
M. P. 248 - 250°C
Density 1.65 @20°/20°C
Toxicity: See Zinc Compounds.
Toxicology: Zinc dimethyldithiocarbamate is very irritating to the eyes, nose and throat. Several hours after this material gets into the eyes, the pain becomes

unbearable. A seed disinfectant and fungicide.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of sulfur and cyanides.
Storage and Handling: Section 7

ZINC DIMETHYLDITHIOCARBAMATE-CYCLOHEXYLAMINE COMPLEX

Description: White powder.
Toxicity: A fungicide. See Zinc Compounds and Cyclohexylamine.
Fire Hazard: Moderate, when exposed to heat or flame (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of sulfur and cyanides; can react with oxidizing materials.
Storage and Handling: Section 7

ZINC DITHIOCARBAMATE

Toxicity: See Zinc Compounds.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of sulfur and cyanides.
Storage and Handling: Section 7

ZINC ETHYL. See Zinc Diethyl.

ZINC FERROCYANIDE

Description: White powder.
Formula: $Zn_2Fe(CN)_6$
Constant: Mol. Wt. 342.72
Toxicity: See Zinc Compounds and Ferrocyanides.
Disaster Control: See Ferrocyanides.
Storage and Handling: Section 7

ZINC FLUOGALLATE

Description: Colorless crystals.
Formula: $[Zn(H_2O)_6](GaF_55H_2O)$
Constants:
Mol. Wt. 356.2
M. P. $-5H_2O$ @110°C
Density 2.33
Toxicity: See Fluogallates.
Disaster Control: See Fluogallates.
Storage and Handling: Section 7

ZINC FLUORIDE

Description: White powder.
Formula: ZnF_2
Constants: Mol. Wt. 103.38
M. P. 872°C
B. P. 1497°C
Density 4.84 @15°C
Vap. Press. 1 mm @970°C
Toxicity: See Fluorides and Zinc Compounds.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

ZINC FLUOSILICATE

Description: Hexagonal, colorless prisms.
Formula: $ZnSiF_6 \cdot 6H_2O$
Constants:
Mol. Wt. 315.5
Density 2.104
Toxicity: See Fluosilicates.
Disaster Control: See Fluosilicates.
Storage and Handling: Section 7

ZINC FORMALDEHYDE SULFOXYLATE

Description: Rhombic prisms.
Formula: $Zn(HSO_2 \cdot CH_2O)_2$
Constants:
Mol. Wt. 255.6
M. P. Decomposes
Toxicity: See Zinc Compounds and Formaldehyde.
Disaster Control: Dangerous; when heated to decomposition it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

ZINC FORMATE

Description: White crystals.
Formula: $Zn(CHO_2)_2$
Constants: Mol. Wt. 155.4
B. P. Decomposes
Density 2.36
Toxicity: See Zinc Compounds and Formic Acid.
Disaster Control: Moderately dangerous; may emit toxic fumes of zinc compounds.
Storage and Handling: Section 7

ZINC GALLATE

Description: White crystals.
Formula: $ZnGa_2O_4$
Constants:
Mol. Wt. 268.8
M. P. Below 800°C
Density 6.15 (theor.)
Toxicity: See Zinc Compounds and Gallium Compounds.
Disaster Control: Moderately dangerous; when heated to

decomposition it may emit toxic fumes of zinc compounds.
Storage and Handling: Section 7

ZINC HYDROXIDE
Description: White powder.
Formula: $Zn(OH)_2$
Constants: Mol. Wt. 99.4
M. P. 125°C (decomp.)
Density 3.053
Toxicity: See Zinc Compounds.
Fire Hazard: Slight; when heated it emits toxic fumes.
Storage and Handling: Section 7

ZINC HYPOPHOSPHITE
Description: Colorless, hygroscopic cyrstalline powder.
Formula: $Zn(H_2PO_2)_2 \cdot H_2O$
Constant:
Mol. Wt. 213.4
Toxicity: See Zinc Compounds.
Fire Hazard: See Hypophosphites.
Explosion Hazard: See Hypophosphites.
Disaster Control: See Hypophosphites.
Storage and Handling: Section 7

ZINC IODATE
Description: White crystalline powder.
Formula: $Zn(IO_3)_2$
Constants:
Mol. Wt. 415.2
M. P. Decomposes
Density 4.98
Toxicity: See Iodates and Zinc Compounds.
Fire Hazard: See Iodates.
Explosion Hazard: See Iodates.
Disaster Control: See Iodates.
Storage and Handling: Section 7

ZINC IODIDE
Description: Cubic, colorless or white, deliquescent powder.
Formula: ZnI_2
Constants:
Mol. Wt. 319.22
M. P. 446°C
B.P. 624°C
Density 4.666 @14.2°C
Toxicity: See Iodides and Zinc Compounds.
Disaster Control: See Iodides.
Storage and Handling: Section 7

ZINC LAURATE
Description: White powder.
Formula: $Zn(C_{12}H_{23}O_2)_2$
Constants:
Mol. Wt. 464.0
M. P. 128°C
Toxicity: See Zinc Compounds.
Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials (Section 6).
Storage and Handling: Section 7

ZINC MERCAPTOBENZOTHIAZOLE
Toxicity: Details unknown; a fungicide. See Zinc Compounds.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of oxides of sulfur.
Storage and Handling: Section 7

ZINC MERCURY CHROMATE
Toxicity: See Chromium Compounds and Mercury Compounds.
Fire Hazard: Moderate, by chemical reaction as an oxidizer (Section 6).
Disaster Control: See Mercury Compounds, Inorganic.
Storage and Handling: Section 7

ZINC NAPHTHENATE
Description: A solid.
Formula: $Zn(C_6H_5COO)_2$
Constant:
Mol. Wt. 319.7
Toxicity: A fungicide and mildew preventive. See Zinc Compounds.
Fire Hazard: Slight, when exposed to heat or flame (Section 6).
Storage and Handling: Section 7

ZINC NITRATE
Description: A: Needles; B. Tetragonal, colorless crystals.
Formula: A: $Zn(NO_3)_2 \cdot 3H_2O$;
B: $Zn(NO_3)_2 \cdot 6H_2O$
Constants:
Mol. Wt. A: 243.33; B: 297.49
Density B: 2.065 @14°C
M. P. A: 45.5°C; B: 36.4°C
B. P. B: $-6H_2O$ @105 - 131°C
Toxicity: See Nitrates and Zinc Compounds.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.

Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material.

ZINC OXALATE
Description: White powder.
Formula: $ZnC_2O_4 \cdot 2H_2O$
Constants:
Mol. Wt. 189.43
M. P. Sublimes 100°C
Density 2.562 @24.5°C
Toxicity: See Oxalates and Zinc Compounds.

ZINC OXIDE
Synonyms: Zincite; Chinese white; zinc white; flowers of zinc.
Description: White or yellowish powder.
Formula: ZnO
Constants:
Mol. Wt. 81.38
M. P. Above 1800°C
Density 5.47
Toxicity: A seed disinfectant. See Zinc Compounds.
MAC: ACGIH (accepted); 15 million particles per cubic foot.

ZINC OXYSULFATE
Description: White powder.
Formula: $ZnO \cdot ZnSO_4$
Constant:
Mol. Wt. 242.8
Toxicity: See Zinc Compounds.
Disaster Control: See Sulfates.

ZINC PERMANGANATE
Description: Violet-brown or black, hygroscopic crystals.
Formula: $Zn(MnO_4)_2 \cdot 6H_2O$
Constants:
Mol. Wt. 411.34
M. P. $-5H_2O$ @100°C
Density 2.47
Toxicity: See Manganese Compounds.
Fire Hazard: Moderate, by chemical reaction with reducing agents. A powerful oxidizing agent (Section 6).
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

ZINC PEROXIDE
Description: Yellow-white powder.
Formula: ZnO_2 (theoretical)
Constants:
Mol. Wt. 97.38
Density 1.571 (theoretical)
Toxicity: Systemic toxicity is similar to zinc oxide. See Peroxides and Zinc Compounds.
Fire Hazard: Moderate, when exposed to heat or by chemical reaction with reducing materials. Finely divided powder is slightly soluble in water, decomposes rapidly at 150°C. It is not dangerous unless mixed with highly combustible materials (Section 6).
Explosion Hazard: Moderate, when exposed to heat.
Explosive Range: @212°C for peroxide prepared from $ZnSO_4$ NH_3, H_2O_2; $4ZnO \cdot H_2O \cdot 3H_2O_2$ explodes at 190°C.
Disaster Control: Very dangerous; it explodes when heated; it will react with water or steam to produce heat; on contact with reducing material, it can react vigorously.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
I.C.C. Classification: Oxidizing material; yellow label.
Coast Guard Classification: Oxidizing material; yellow label.

ZINC PHOSPHIDE
Description: Cubic, dark gray crystals or powder.
Formula: Zn_3P_2
Constants:
Mol. Wt. 258.10
M. P. > 420°C
B. P. 1100°C
Density 4.55 @13°C
Toxicity: See Phosphides and Zinc Compounds.
Fire Hazard: See Phosphides.
Explosion Hazard: See Phosphides.
Disaster Control: See Phosphides.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
MCA warning label.

ZINC PICRATE
Description: Yellow, crystalline powder.
Formula: $Zn(C_6H_2N_3O_7)_2 \cdot 8H_2O$
Constants:
Mol. Wt. 665.7
M. P. Explodes
Toxicity: See Picrates and Zinc Compounds.
Fire Hazard: Dangerous. See Nitrates.
Explosion Hazard: Severe. See Explosives, High and Nitrates.
Disaster Control: Dangerous. See Nitrates.
Storage and Handling: Section 7

ZINC RICINOLEATE
Description: Fine, white powder.
Formula: $ZnCO_2(CH_2)_7CH = CHCH_2CHOH(CH_2)_5(CH_3)_2$
Constants:
Mol. Wt. 655
M. P. 92°C
Density 1.10 @25°/25°C
Toxicity: See Zinc Compounds.
Fire Hazard: Slightly dangerous; when heated it emits toxic fumes.
Storage and Handling: Section 7

ZINC SELENATE
Description: Triclinic crystals.
Formula: $ZnSeO_4 \cdot 5H_2O$
Constants:
Mol. Wt. 298.42
M. P. Decomposes > 50°C
Density 2.591
Toxicity: See Selenium Compounds.
Disaster Control: See Selenium.
Storage and Handling: Section 7

ZINC SELENIDE
Description: Cubic crystals.
Formula: $ZnSe$
Constants:
Mol. Wt. 144.34
Density 5.42 @15°C
Toxicity: See Selenium Compounds.
Fire Hazard: Moderate, on contact with moisture or acids it can evolve selenium hydride. See Hydrides.
Explosion Hazard: Moderate; it can evolve a hydride. See Hydrides.
Disaster Control: See Selenium.
Storage and Handling: Section 7

ZINC SILICOFLUORIDE. See Zinc Fluosilicate.

ZINC STEARATE
Description: White powder.
Formula: $Zn(C_{18}H_{35}O_2)_2$
Constants:
Mol. Wt. 632.30
M. P. 130°C
Flash P. 530°F (O.C.)
Autoign. Temp. 790°F
Toxicity: See Zinc Compounds.
Fire Hazard: Slight, when exposed to heat or flame.
To Fight Fire: Water, foam, carbon dioxide, dry chemical or carbon tetrachloride (Section 6).
Storage and Handling: Section 7

ZINC SULFATE
Synonym: Zinkosite.
Description: Rhombic, colorless crystals.
Formula: $ZnSO_4$
Constants:
Mol.Wt. 161.44
M. P. Decomposes @740°C
Density 3.74 @15°C
Toxicity: See Zinc Compounds and Sulfuric Acid.
Disaster Control: See Sulfates.

ZINC SULFIDE, (ALPHA)
Synonym: Wurtzite.
Description: Hexagonal, colorless crystals.
Formula: ZnS
Constants:
Mol. Wt. 97.45
M. P. 1850°C @150 atm.
B. P. Sublimes @1185°C
Density 4.087
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

ZINC SULFITE
Description: White, crystalline powder.
Formula: $ZnSO_3 \cdot 2H_2O$
Constant:
Mol. Wt. 181.48
Toxicity: See Sulfites and Zinc Compounds.
Disaster Control: See Sulfites.
Storage and Handling: Section 7

ZINC TELLURATE

Description: Heavy, granular, white precipitate.
Formula: Zn_3TeO_6
Constant:
Mol. Wt. 419.75
Toxicity: See Tellurium Compounds.
Disaster Control: See Tellurium Compounds.
Storage and Handling: Section 7

ZINC TELLURIDE

Description: Cubic, red crystals.
Formula: ZnTe
Constants:
Mol. Wt. 192.99
M. P. 1238.5°C
Density 6.34 @15°C
Toxicity: See Tellurium Compounds.
Fire Hazard: Moderate; upon contact with moisture or acids it evolves tellurium hydride.
Explosion Hazard: Slight; it can easily evolve the hydride of tellurium. See Hydrides.
Disaster Control: See Tellurium Compounds.
Storage and Handling: Section 7

ZINC THIOCYANATE

Description: White powder.
Formula: $Zn(SCN)_2$
Constant:
Mol. Wt. 181.55
Toxicity: See Thiocyanates and Zinc Compounds.
Disaster Control: See Thiocyanates.
Storage and Handling: Section 7

ZINC-2,4,5-TRICHLOROPHENATE

Description: Colorless crystals.
Formula: $Zn(OC_6H_2Cl_3)_2$
Constant:
Mol. Wt. 458.3
Toxicity: A fungicide and seed protectant. See Trichlorophenol.
Disaster Control: Dangerous; when heated to decomposition or on contact with acid or acid fumes, it emits highly toxic fumes of chlorides
Ventilation Control: Section 2
Storage and Handling: Section 7

ZIRCONIUM

Description: Hard, lustrous, grayish, crystalline scales or gray powder.
Formula: Zr
Constants:
At. Wt. 91.22
M. P. 1900°C
B. P. Above 2900°C
Density 6.5
Autoign. Temp. 500°F
Toxicity: See Zirconium Compounds.
MAC: ACGIH (tentative); 5 milligrams per cubic meter of air.
Radiation Hazard: Artificial isotope Zr^{95}, half-life: 65 days, emits beta particles of 0.4 mev and gamma rays between 0.24 - 0.71 mev.

Zr^{95} may be contaminated with its daughter, Nb^{95}. Hazard Rating, Class III (National Bureau of Standards Handbook No. 42).
Fire Hazard: Dangerous, in the form of dust when exposed to heat or flame or by chemical reaction with oxidizers.
Spontaneous Heating: No
To Fight Fire: Special mixtures, dry chemical, salt or dry sand (Section 6).
Explosion Hazard: Dangerous in the form of dust by chemical reaction with air, oxidizing agents.
Explosive Range: 0.16 g/l.
Storage and Handling: Section 7

ZIRCONIUM AMMONIUM FLUORIDE

Description: A: Rhombic, white crystals; B: Colorless, cubic cyrstals.
Formula: A: $(NH_4)_2ZrF_6$;
B: $(NH_4)_3ZrF_7$
Constants:
Mol. Wt. A: 243.0; B: 278.34
Density 1.154
Toxicity: See Fluorides.
Disaster Control: See Fluorides.
Storage and Handling: Section 7

ZIRCONIUM CARBIDE

Description: Hard gray, metallic crystals.
Formula: ZrC
Constants:
Mol. Wt. 103.23
M. P. 3540°C
B. P. 5100°C
Density 6.73
Toxicity: See Acetylene and

Zirconium Compounds.
Fire Hazard: See Carbides.
Explosion Hazard: See Carbides.
Disaster Control: See Carbides.
Storage and Handling: Section 7

ZIRCONIUM COMPOUNDS

Toxicity: Zirconium is not an important poison, and so far as is known, the inherent toxicity of zirconium compounds is low. Deaths in rabbits have been caused by it through intravenous injection of relatively large doses of the order of 150 mg/kg of body weight. Most of the zirconium compounds in common use are insoluble and considered to be inert.

ZIRCONIUM DIBROMIDE

Description: Black powder.
Formula: $ZrBr_2$
Constants:
Mol. Wt. 251.05
M. P. Decomposes > 350°C
Toxicity: See Bromides.
Fire Hazard: Dangerous by spontaneous chemical reaction. Ignites spontaneously in air (Section 6).
Explosion Hazard: Unknown
Disaster Control: Dangerous; on decomposition it emits toxic fumes of bromides; can react vigorously with oxidizing materials.
Storage and Handling: Section 7

ZIRCONIUM DICHLORIDE

Description: Black crystals.
Formula: $ZrCl_2$
Constants:
Mol. Wt. 162.13
M. P. Decomposes > 350°C
Toxicity: See Hydrochloric Acid.
Disaster Control: Dangerous; on decomposition it emits highly toxic fumes of chlorides.
Storage and Handling: Section 7

ZIRCONIUM DIOXIDE

Synonym: Baddelyite.
Description: Colorless, yellow or brown, monoclinic crystals.
Formula: ZrO_2
Constants:
Mol. Wt. 123.22
M. P. 2700°C
B. P. 4300°C
Density 5.49
Toxicity: See Zirconium Compounds.

ZIRCONIUM HYDRIDE

Description: Metallic dark-gray to black powder.
Formula: ZrH_2
Constants:
Mol. Wt. 93.23
Density 5.6
Autoign. Temp. 270°C in air
Toxicity: See Hydrides and Zirconium Compounds.
Fire Hazard: See Hydrides.
Explosion Hazard: See Hydrides.
Disaster Control: See Hydrides.
Storage and Handling: Section 7

ZIRCONIUM, METALLIC DRY.

See Zirconium.
Shipping Regulations: Section 11.
I. C. C. Classification: Flammable solid; yellow label.
Coast Guard Classification: Inflammable solid; yellow label; (Metallic solutions or mixtures thereof, liquid) inflammable liquid; red label.

ZIRCONIUM NITRATE

Description: White crystals.
Formula: $Zr(NO_3)_4 \cdot 5H_2O$
Constants:
Mol. Wt. 429.33
M. P. Decomposition @100°C
Toxicity: See Nitrates.
Fire Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
Coast Guard Classification: Oxidizing material.

ZIRCONIUM NITRIDE

Description: Brassy colored powder. Refractory.
Formula: ZrN
Constants: Mol. Wt. 105.22
M. P. 2930 - 2980°C
Density 7.09
Toxicity: Details unknown; probably low.

ZIRCONIUM PHOSPHIDE

Description: Gray crystals.
Formula: ZrP_2
Constants: Mol. Wt. 153.2
Density 4.77 @25°/4°C

Toxicity: See Phosphides.
Fire Hazard: See Phosphides.
Explosion Hazard: See Phosphides.
Disaster Control: See Phosphides.
Storage and Handling: Section 7

ZIRCONIUM PICRAMATE, WET WITH 20% OF WATER

Toxicity: Details unknown. See Nitrates.
Fire Hazard: See Nitrates.
Explosion Hazard: See Nitrates.
Disaster Control: See Nitrates.
Storage and Handling: Section 7
Shipping Regulations: Section 11.
  I. C. C. Classification: Oxidizing material; yellow label.
  Coast Guard Classification: Oxidizing material; yellow label.

ZIRCONIUM SELENATE

Description: Hexagonal, transparent crystals.
Formula:
  $Zr(SeO_4)_2 \cdot 4H_2O$
Constants:
  Mol. Wt. 449.20
  M. P. $-3H_2O$ @100°C; $-4H_2O$ @130°C
Toxicity: See Selenium.
Disaster Control: See Selenium Compounds.
Storage and Handling: Section 7

ZIRCONIUM SULFIDE

Description: Steel-gray crystals.
Formula: ZrS_2
Constants:
  Mol. Wt. 155.35
  Density 3.87
Toxicity: See Sulfides.
Fire Hazard: See Sulfides.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

ZIRCONIUM TETRACHLORIDE

Description: White, lustrous crystals.
Formula: $ZrCl_4$
Constants:
  Mol. Wt. 233.05
  M. P. Sublimes @300°C
  B. P. 331°C
  Density 2.80
  Vap. Press. 1 mm @190°C
Toxicity: See Hydrochloric Acid.
Disaster Control: Moderately dangerous; when heated to decomposition it emits toxic fumes of hydrochloric acid.
Storage and Handling: Section 7

ZIRCONIUM, WET OR SLUDGE.

  See Zirconium.
Shipping Regulations: Section 11.
  I. C. C. Classification: Flammable solid; yellow label.
  Coast Guard Classification: Inflammable solid; yellow label.

ZIRCONYL BROMIDE

Description: Brilliant, deliquescent crystals.
Formula: $ZrOBr_2 \cdot xH_2O$
Constant:
  M. P. $-H_2O$ @120°C
Toxicity: See Hydrogen Bromide.
Disaster Control: See Bromides.
Storage and Handling: Section 7

ZIRCONYL SULFIDE

Description: Yellow powder.
Formula: ZrOS
Constants: Mol. Wt. 139.29
  Density 4.87
Toxicity: See Sulfides.
Fire Hazard: See Sulfides. Ignites in air.
Explosion Hazard: See Sulfides.
Disaster Control: See Sulfides.
Storage and Handling: Section 7

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Section 11

SHIPPING REGULATIONS

Interstate Commerce Commission

(Bureau of Explosives)

June 18, 1957

Foreword

This section is included for several reasons. In the first place it is a convenient source of reference for information on packaging and shipping of dangerous materials. In this respect it must be remembered that *not all* dangerous materials have shipping regulations covering them, only the better known ones.

In the second place, reference to the packaging and shipping regulations for a material often gives a clue to its safe handling in the laboratory as well as in the factory.

Finally, it is hoped that placing the Regulations in this book will awaken an awareness of the shipper's responsibility for the materials he ships.

Section 10 is so arranged that each material which is covered by a shipping regulation is so noted, and by simply referring to § 72.5 of the Shipping Regulations one can find the paragraphs in § 73, § 74, and § 75 which apply. These paragraphs are included in full. They are taken from Tariff No. 10, which is the latest complete compilation of the Bureau of Explosives' Shipping Regulations.

When it is necessary to check Shipping Container Specifications reference must be made to copies of Agent H. A. Campbell's Tariff No. 10 and Supplements,

Issued by: H. A. Campbell, Agent
30 Vesey Street
New York 7, N. Y.

SHIPPING REGULATIONS

Interstate Commerce Commission

Bureau of Explosives Tariff No. 10

Effective June 18, 1957

PUBLIC LAW 772, 80th CONGRESS (62 Stat. 738) (Approved June 25, 1948, Effective September 1, 1948)

AN ACT To revise, codify, and enact into positive law, Title 18 of the United States Code.

CHAPTER 39.—EXPLOSIVES AND COMBUSTIBLES

Sec.
831. Definitions.
832. Transportation of dynamite, powder and fuses.
833. Transportation of nitroglycerin.
834. Marking packages containing explosives.
835. Regulations by Interstate Commerce Commission.

§ 831. DEFINITIONS

As used in this chapter—

"**Detonating fuzes**" means fuzes used in naval or military service to detonate the high-explosive bursting charges of projectiles, mines, bombs, or torpedoes;

"**Fuzes**" means devices used in igniting the bursting charges of projectiles;

"**Primers**" means devices used in igniting the propelling powder charges of ammunition;

"**Fuses**" means the slow-burning fuses used commercially to convey fire to an explosive combustible mass slowly or without danger to the person lighting same;

"**Fusees**" means the fusees ordinarily used on steamboats and railroads as night signals.

§ 832. TRANSPORTATION OF DYNAMITE, POWDER AND FUSES

Whoever knowingly transports, carries, or conveys within the limits of the jurisdiction of the United States, any high explosive, such as and including dynamite, blasting caps, detonating fuzes, black powder, gunpowder, or other like explosive, on any car or vehicle of any description operated in the transportation of passengers by a common carrier engaged in interstate or foreign commerce, which car or vehicle is carrying passengers for hire, shall be fined not more than $1,000 or imprisoned not more than one year, or both; and, if the death or bodily injury of any person results from a violation of this section, shall be fined not more than $10,000 or imprisoned not more than ten years, or both.

However, under this section, it shall be lawful to transport on any such car or vehicle, smokeless powder, primers, fuses, not including detonating fuzes, fireworks, or other similar explosives, and properly packed and marked samples of explosives for laboratory examination, not exceeding a net weight of one-half pound each, and not exceeding twenty samples at one time in a single car or vehicle; but such explosives shall not be carried in that part of a car or vehicle which is being used for the transportation of passengers for hire. Also, it shall be lawful to transport on any such car or vehicle small-arms ammunition in any quantity, and such fusees, torpedoes, rockets, or other signal devices as may be essential to promote safety in operation. This section shall not prevent the transportation of military or naval forces with their accompanying munitions of war on passenger-equipment cars or vehicles.

§ 833. TRANSPORTATION OF NITROGLYCERIN

Whoever knowingly transports, carries, or conveys within the jurisdiction of the United States, liquid nitroglycerin, fulminate in bulk in dry condition, or other like explosive, on any car or vehicle of any description operated in the transportation of passengers or property by land or water by a common carrier engaged in interstate or foreign commerce, shall be fined not more than $1,000 or imprisoned not more than one year, or both; and, if the death or bodily injury of any person results from a violation of this section, shall be fined not more than $10,000 or imprisoned not more than ten years, or both.

§ 834. MARKING PACKAGES CONTAINING EXPLOSIVES

Whoever knowingly delivers to any common carrier engaged in interstate or foreign commerce by land or water, or carries upon any car or vehicle operated by any common carrier engaged in interstate or foreign commerce by land any explosive, or other dangerous article, specified in section 832 of this title, under any false or deceptive marking, description, invoice, shipping order, or other declaration or without informing the agent of such carrier in writing of the true character thereof, at or before the time such delivery or carriage is made, or without plainly marking on the outside of every package containing explosives or other dangerous articles the contents thereof, shall be fined not more than $1,000 or imprisoned not more than one year, or both; and, if the death or bodily injury of any person results from a violation of this section, shall be fined not more than $10,000 or imprisoned not more than ten years, or both.

§ 835. REGULATIONS BY INTERSTATE COMMERCE COMMISSION

The Interstate Commerce Commission shall formulate regulations for the safe transportation within the limits of the jurisdiction of the United States of explosives and other dangerous articles, including flammable liquids, flammable solids, oxidizing materials, corrosive liquids, compressed gases, and poisonous substances, which shall be binding upon all common carriers engaged in interstate or foreign commerce which transport explosives or other dangerous articles by land, and upon all shippers making shipments of explosives or other dangerous articles via any common carrier engaged in interstate or foreign commerce by land or water.

The commission, of its own motion, or upon application made by any interested party, may make changes or modifications in such regulations, made desirable by new information or altered conditions.

Such regulations shall be in accord with the best-known practicable means for securing safety in transit, covering the packing, marking, loading, handling while in transit, and the precautions necessary to determine whether the material when offered is in proper condition to transport.

Such regulations, as well as all changes or modifications thereof, shall, unless a shorter time is authorized by the commission, take effect ninety days after their formulation and publication by said commission and shall be in effect until reversed, set aside, or modified.

In the execution of sections 831-835 of this title the Interstate Commerce Commission may utilize the services of the Bureau for the Safe Transportation of Explosives and Other Dangerous Articles, and may avail itself of the advice and assistance of any department, commission, or board of the Government, but no official or employee of the United States shall receive any additional compensation for such service except as now permitted by law.

Whoever knowingly violates any such regulation shall be fined not more than $1,000 or imprisoned not more than one year, or both; and, if the death or bodily injury of any person results from such violation, shall be fined not more than $10,000 or imprisoned not more than ten years, or both.

PART 71—GENERAL INFORMATION AND REGULATIONS

Sec.

71.1 Plan of the regulations in Parts 71-78.
71.2 Act of Congress.
71.3 Changes in the regulations, shippers by rail, highway, and water, and carriers by rail and highway.
71.4 Changes in tank car specifications.
71.5 Procedure covering tank car construction.
71.6 Approved changes; notice.
71.7 Public hearings.
71.8 Definitions.
71.9 Vessels stores.
71.10 Flammable or combustible liquids in bulk on board vessels.
71.11 Transportation by carriers by water.
71.12 Export shipments by domestic carriers by rail and motor vehicles.
71.13 Emergency regulations.

§ 71.1 **Plans of the regulations in Parts 71-78.** (a) Regulations in Parts 71-78 cover preparation of explosives and other dangerous articles for transportation by common carriers by rail freight, rail express, rail baggage, highway or water, construction of containers, packing, weight, marking, labeling when required, billing, and shipper's certificate of compliance with these regulations; also cars, loading, storage, billing, placarding, and movement thereof by carriers by rail.

(b) Regulations for equipment and operation of motor vehicles on the highways are published in separate issue of the Commission.

§ 71.2 **Act of Congress.** (a) Section 834, Title 18 of the United States Code, approved June 25, 1948 (Pub. Law 772, 80th Cong.), provides that whoever knowingly delivers to any common carrier engaged in interstate or foreign commerce by land or water, or carries upon any car or vehicle operated by any common carrier engaged in interstate or foreign commerce by land, any explosive or other dangerous article specified in section 832, under any false or deceptive marking, description, invoice, shipping order or declaration, or without informing the agent of such carrier, in writing, of the true character thereof, or does not plainly mark on the outside of every package containing explosives or other dangerous articles the contents thereof, shall be fined or imprisoned, or both, as provided in this act.

§ 71.3 **Changes in the regulations, shippers by rail, highway, and water, and carriers by rail and highway.** (a) Section 835 of the act of June 25, 1948, authorizes the Commission to formulate regulations for the safe transportation of explosives and other dangerous articles and either upon its own motion, or upon application by any interested party, to make changes or modifications in such regulations, made desirable by new information or altered conditions. It further provides that in the execution of sections 831-835 of the act the Commission may utilize the services of the Bureau for the Safe Transportation of Explosives and other Dangerous Articles (hereinafter called Bureau of Explosives). The Bureau of Explosives will make inspections and conduct investigations and will confer with manufacturers and shippers with a view to determining what regulations will within reasonable limits afford the highest degree of safety in preparing and packing explosives and other dangerous articles for transportation by carriers by rail, highway, or water. The Commission will give due weight to the expert opinions thus obtained. Reports of these investigations will be made to the Commission with recommendations.

(b) Specifications for shipping containers, methods of packing for shipment, and other regulations will be considered and prescribed from time to time by orders effective as conditions may appear to warrant.

§ 71.4 **Changes in tank car specifications.** (a) Proposals of changes in or additions to specifications for tanks to be mounted on or to form part of a car and to be classified as tank cars should be submitted to the Secretary, Mechanical Division, Association of American Railroads, for thorough investigation and consideration by its committee on tank cars, that committee to report its recommendations, together with objections offered to its proposals, with explanations and reasons for desired approval thereof, through said secretary to the Commission, and such reports may be submitted to the Bureau of Explosives, as circumstances appear to warrant, for comments and suggestions before appropriate action by the Commission.

§ 71.5 **Procedure covering tank car construction.** (a) Complete detailed prints of new or improved types of tank-car tanks and detailed prints or samples of new or improved types of equipment therefor should be submitted to the Secretary, Mechanical Division, Association of American Railroads, for thorough investigation and laboratory tests of samples by its committee on tank cars.

(b) When in the opinion of the committee such tanks or equipment therefor are in full compliance with effective specifications of the Commission and no increase in hazard is involved, their use should be permitted.

(c) When in the opinion of the committee such tanks or equipment therefor are in full compliance with effective specifications of the Commission and a possible increase in hazard is involved, service trials should be agreed upon among interested parties before more extended use is permitted.

(d) When in the opinion of the committee such tanks or equipment therefor do not comply with effective specifications of the Commission and service trials are desirable, approval by the Commission of the conditions of such trials must be obtained.

(e) Prompt reports of the tank car committee on these matters should be made to the Commission through said mechanical division secretary and should include objections to proposed modifications of the specifications and advice of any extensions of pending investigations found necessary. The committee's expert opinions thus obtained will be given due weight by the Commission in determining upon appropriate final action to be taken. The merits of controversies arising under the foregoing procedure will be considered and changes in or additions to the specifications, or authorizations of service trials, will be made by the Commission as conditions appear to warrant.

§ 71.6 **Approved changes; notice.** (a) The act of June 25, 1948, requires that notice of 90 days after formulation and publication should be given of the effective date of new or modified regulations, unless a shorter time is authorized by the Commission. The authority to establish amended regulations upon less than 90 days' notice will be exercised only in instances where special and peculiar circumstances or conditions fully justify it.

§ 71.7 **Public hearings.** (a) Public hearings concerning regulations contained in Parts 71-78 will be held by the Commission at sufficiently frequent intervals. At these hearings evidence may be introduced in favor of proposed changes or additions and protest against the adoption thereof will also be heard. Final action also may be taken by the Commission without hearing, following 20 days' notice by the Commission of proposed changes or additions, or without such notice, as conditions appear to warrant.

§ 71.8 **Definitions.** (a) The word "must" or "shall" is used in Parts 71-78 in mandatory regulations. The word "should" indicates recommendatory provisions.

(b) In section 832 of the act of June 25, 1948: **It is provided,** That whoever knowingly transports certain explosives on any car or vehicle of any description operated in the transportation of passengers by a common carrier engaged in interstate or foreign commerce, which car or vehicle is carrying passengers for hire, shall be fined or imprisoned or both. **It is further provided,** That under limited conditions, certain explosives may be transported in a single car or vehicle but such explosives shall not be carried in that part of a car or vehicle which is being used for the transportation of passengers for hire. As used in Parts 71-78 the term "car or vehicle of any description operated in the transportation of passengers * * * for hire" means any railroad car of a passenger train, or highway vehicle, with passengers for hire in the same such railroad car or highway vehicle.

(c) Whenever use of a container type is prescribed in the packing regulations but without specification number, the authorized type of container, either specification or nonspecification, may be used for the shipment.

(d) Numbering and lettering. The terms used in the numbering and lettering system employed in Parts 71-78, and adhered to in references made from one requirement to another, are as follows:

(1) Section: A major subdivision of a part, as §73.193.

(2) Paragraph: A subdivision of a section, as paragraph (a) of this section, or § 73.193 (a).

(3) Subparagraph: A subdivision of a paragraph, as paragraph (a) (1) of this section, or § 73.193 (a) (1).

(e) Tank motor vehicle. The term "tank motor vehicle" means any motor vehicle designed or used for the transportation of liquids or gases covered by Parts 71-78 in any cargo tank.

(f) Cargo tank. The term "cargo tank" means:

(1) **Permanently attached tank.** Any tank designed to be permanently attached to any motor vehicle and in which is to be transported any flammable liquid, corrosive liquid, or compressed gas, hereby designated "cargo tank."

(2) **Fuel tank not a cargo tank.** A fuel tank is not a cargo tank, but one used to transport flammable liquid or compressed gas solely for the purpose of supplying fuel for the propulsion of a vehicle.

(g) The term "portable tank" means any tank designed primarily to be temporarily attached to a motor vehicle, other vehicle, railroad car other than tank car, or vessel, and equipped with skids, mountings or accessories to facilitate handling of the tank by mechanical means. The term "portable tank" shall not be construed to include any cargo tank, any tank car tank, or any tank of the ICC 106A type.

§ **71.9 Vessels stores.** (a) Vessels stores are regulated by the regulations prescribed by the Commandant of the Coast Guard (46 CFR Part 147) and are not included in Parts 71-78.

§ **71.10 Flammable or combustible liquids in bulk on board vessels.** (a) Nothing in Parts 71-78 shall be construed as affecting the transportation of flammable or combustible liquids in bulk on board vessels which transportation is governed by the rules and regulations promulgated under R. S. 4417a; 47 U. S. C. 391a (46 CFR Part 146).

§ **71.11 Transportation by carriers by water.** (a) When the transportation of a shipment involves movement by carrier by water, the applicable provisions of Parts 71-78 must be observed by the shipper.

§ **71.12 Export shipments by domestic carriers by rail and motor vehicles.** (a) Explosives and other dangerous articles authorized to be exported from the United States when packed, marked, labeled, and described, in accordance with rules and regulations in force at destination ports, must not be offered to any common carrier by rail or motor vehicle for domestic transportation unless in full accordance with the regulations in Parts 71-78.

(b) Except for the requirements of §§ 77.817 and 77.823, the provisions of Parts 71-78 do not apply to such transportation by motor vehicle or water as may be necessary to effect transfer of export shipments from place of shipment to other places within the same port area or delivery to a water carrier within the same port area (including contiguous harbors). Further transportation of such export shipments by connecting water carrier shall be subject to the regulations prescribed by the Commandant of the Coast Guard.

§ **71.13 Emergency regulations.** (a) Until further order of the Commission, shipments of explosives may be made upon request of the Departments of the Army, Navy, and Air Force of the United States Government complying with the following:

(1) Shippers' and carriers' regulations; handling detonating agents and explosives and explosive ammunition in same car or vehicle. Detonating fuzes, primer-detonator assemblies or other detonating elements containing explosive components, if of a safe type, may be shipped either assembled in bombs, depth charges, mines, projectiles, or torpedoes (torpedo warheads) or in properly packed containers in the same car or vehicle with bombs, depth charges, mines, projectiles, boosters or torpedoes (torpedo warheads) when separated from the explosive bombs, depth charges, mines, projectiles, boosters, or torpedoes (torpedo warheads) by not less than 3 feet. The intervening space of 3 feet must be filled with dry sand or dry earth in bags or in a crib so constructed or lined as to prevent sifting of the sand or earth. The crib must be secured against movement.

(2) When bomb fuzes are packed with bomb fin assemblies, either crated or boxed in wooden or metal containers, the sand or earth filled space between bombs and the fuzes may be omitted provided adequate blocking and bracing is supplied to prevent the bombs from crushing and injuring the detonating fuzes due to ordinary shocks incident to transportation.

(3) Shipments of explosive bombs, unfuzed explosive projectiles, and jet thrust units when not packed in wooden boxes, and large metal containers or incendiary bombs weighing 500 pounds or more, each, may be loaded in stock cars or in gondola cars (flat bottom) when adequately braced. Wooden boxed bombs or jet thrust units which, due to size, cannot be loaded in closed cars may be loaded in open top cars but must be protected against accidental ignition.

PART 72—COMMODITY LIST OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES CONTAINING THE SHIPPING NAME OR DESCRIPTION OF ALL ARTICLES SUBJECT TO PARTS 71-78

Sec.

72.1 Proper shipping name.
72.2 Articles not described.
72.3 Labels required and prohibited articles.
72.4 Explanation of signs and abbreviations.
72.5 List of explosives and other dangerous articles.

§ **72.1 Proper shipping name.** (a) The proper shipping name which must be used and shown on outside shipping containers appears in Roman type (not italics). The abbreviations N. O. I. and N.O.I.B.N. may be used in lieu of the abbreviation n.o.s. where it appears in the list of explosives and other dangerous articles.

§ **72.2 Articles not described.** (a) For an article not described by name shown in § 72.5 of this part, when such article is classified as dangerous by §§ 73.115, 73.150, 73.151, 73.240, 73.300, 73.326, 73.343, 73.381, or 73.391, the article must be prepared and offered for shipment in compliance with the regulations for the group within which it is properly classified.

§ **72.3 Labels required and prohibited articles.** (a) Section 72.5 of this part also shows the kind of label when required on shipments of explosives and other dangerous articles and the articles which are prohibited for transportation.

§ 72.4 Explanation of signs and abbreviations. (a) An asterisk indicates that articles may or may not be classed as flammable liquids, flammable solids, oxidizing materials, compressed gases, poisons, or corrosive liquids by Parts 71-78. If so classed, such articles are subject to the regulations prescribed for articles within these definitions.

F. L. — Flammable liquid.
F. S. — Flammable solid.
Oxy. M. — Oxidizing material.
Cor. L. — Corrosive liquid.
Nonf. G. — Nonflammable compressed gas.
F. G. — Flammable compressed gas.
Pois. A. — Poison gas or liquid, class A.
Pois. B. — Poisonous liquid or solid, Class B.
Pois. C. — Tear gas, class C.
Pois. D. — Radioactive materials, class D.
Expl. A. — Class A explosives.
Expl. B. — Class B explosives.
Expl. C. — Class C explosives.
Not accepted — Means not to be offered or accepted for transportation.
Forbidden — Means prohibited by law.
∅ Indicates that articles may be transported as rail baggage.
# Required for rail express shipments only.
## Required for rail express and water shipments only.
N. O. S. — Means not otherwise specified.
N. O. I. — Means not otherwise indexed.
N. O. I. B. N. — Means not otherwise indexed by name.

Note 1: Where the word "INFLAMMABLE" is now painted, stencilled, or otherwise permanently marked on tank cars, cargo tank motor vehicles, portable tanks or other containers, it may be so continued until such tanks or other containers are repainted, restencilled, or both, and at such times shall be replaced with the word "FLAMMABLE" unless otherwise ordered by the Commission.

§ 72.5 List of explosives and other dangerous articles. (a) For explanation of signs and abbreviations see § 72.4 of this part.

LIST OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES

Article	Classed as	Exemptions and Packing (see sec.)	Label required if not exempt	Maximum quantity in 1 outside container by rail express
Acetaldehyde (*ethyl aldehyde*)	F. L.	73.118, 73.119	Red	10 gallons.
Acetone	F. L.	73.118, 73.119	do.	Do.
Acetone cyanhydrin	Pois. B.	73.345, 73.346	Poison	55 gallons.
Acetone oils	F. L.	73.118, 73.119	Red	10 gallons.
Acetyl benzoyl peroxide, solid	Not accepted			Not accepted.
Acetyl benzoyl peroxide, solution	Oxy. M	No exemption, 73.222	Yellow	1 quart.
Acetyl chloride	Cor. L.	73.244, 73.247	White	1 gallon.
Acetyl peroxide, solid	Not accepted			Not accepted.
Acetyl peroxide, solution	Oxy. M	73.153 (b), 73.222	Yellow	1 quart.
Acetylene	F. G.	73.302, 73.309	Red Gas	300 pounds.
Acid carboys, empty	See § 73.29 (c)			
Acids, liquids, n. o. s.	Cor. L.	73.244, 73.245	White	5 pints.
*Acid picric. *See* Picric acid.				
*Acid sludge. *See* *Sludge acid.				
Acrolein, inhibited	F. L.	No exemption, 73.122	Red	1 quart.
Acrylonitrile	F. L.	73.118, 73.119	do.	10 gallons.
Aeroplane flares. *See* Special fireworks.				
Air, compressed	Nonf. G.	73.302, 73.307	Green	300 pounds.
*Alcohol or alcohol, n. o. s.	F. L.	73.118, 73.125	Red	10 gallons.
Alcohol, allyl, liquid	Pois. B.	73.345, 73.346	Poison	55 gallons.
*Alcohol, butyl. *See* Alcohol or alcohol, n. o. s.				
Alcohol, denatured. *See* Alcohol or alcohol, n. o. s.				
Alcohol, ethyl. *See* Alcohol or alcohol, n. o. s.				
*Alcohol, propyl. *See* Alcohol or alcohol, n. o. s.				
*Alcohol, tertiary. *See* Alcohol or alcohol, n. o. s.				
Alcohol, wood (methanol). *See* Alcohol or alcohol, n. o. s.				
Aldrin	Pois. B	73.376	Poison	200 pounds.
*Aldrin, cast solid	See § 73.376 (b)			
*Aldrin mixtures, liquid, with 60 percent or less aldrin	See § 73.361 (b)			
Aldrin mixtures, liquid, with more than 60 percent aldrin	Pois. B.	73.361	Poison	55 gallons.
Aldrin mixtures, dry, with more than 65 percent aldrin	Pois. B.	73.376	Poison	200 pounds.
*Aldrin mixtures, dry, with 65 percent or less aldrin	See § 73.376 (b)			
*Aliphatic mercaptan mixtures	F. L.	No exemption, 73.141	Red	10 gallons.
*Alkaline caustic liquids, n. o. s.	Cor. L.	73.244, 73.249	White	10 gallons.
Alkaline corrosive battery fluid	Cor. L.	73.244, 73.249	do.	55 gallons.
Alkaline corrosive battery fluid with storage battery	Cor. L.	No exemption, 73.258	White	400 pounds.
Alkaline corrosive liquids, n. o. s.	Cor. L.	73.244, 73.249	do.	10 gallons.
Allyl alcohol. *See* Alcohol, allyl, liquid.				
Allyl bromide	F. L.	73.118, 73.119	Red	10 gallons.
Allyl chlorocarbonate. *See* Allyl chloroformate.				
Allyl chloroformate	Cor. L.	No exemption, 73.288	White	5 pints.
Allyl trichlorosilane	Cor. L.	No exemption, 73.280	White	10 gallons.
Aluminum dross	See § 73.173			
*Aluminum liquid (or paint). *See* *Paint, enamel, lacquer, stain, shellac, varnish, etc.				
Aluminum nitrate	Oxy. M.	73.153, 73.182	Yellow	100 pounds.
Aluminum triethyl	F. L.	No exemption, 73.134	Red	Not accepted.
Aluminum trimethyl	F. L.	No exemption, 73.134	Red	Not accepted.
Amatol. *See* High explosives.				
Ammonia, anhydrous. *See* Anhydrous ammonia.				
Ammonium arsenate, solid	Pois. B.	73.364, 73.365	Poison	200 pounds.
Ammonium bichromate	F. S.	73.153, 73.154, 73.235	Yellow	100 pounds.
Ammonium nitrate	Oxy. M	73.153, 73.182	do.	Do.
Ammonium nitrate (organic coating)	Oxy. M.	73.153, 73.182	Yellow	100 pounds.
*Ammonium nitrate—phosphate	Oxy. M.	73.153, 73.182	Yellow	100 pounds.
Ammonium nitrate—carbonate mixtures	Oxy. M.	73.153, 73.182	Yellow	100 pounds.
*Ammonium nitrate mixed fertilizer	Oxy. M.	73.153, 73.182	Yellow	100 pounds.
Ammonium nitrate fertilizer, containing 90 percent or more ammonium nitrate with no organic coating	Oxy. M.	73.153, 73.182	do.	Do.
Ammonium perchlorate	Oxy. M	73.153, 73.154	do.	Do.
Ammonium permanganate	Oxy. M	73.153, 73.154	do.	Do.
Ammonium picrate. *See* High explosives.				
Ammonium picrate, wet (not to exceed 16 ounces).	See § 73.192			
Ammunition, chemical (containing class A poisons, liquids, or gases). See Chemical ammunition.				
Ammunition, chemical (containing class B poisons, liquids, or gases). See Chemical ammunition.				
Ammunition, chemical (containing class C poisons, liquids, or solids). See Chemical ammunition				

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* See §72.4.

LIST OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES—*Continued*

Article	Classed as	Exemptions and Packing (see sec.)	Label required if not exempt	Maximum quantity in 1 outside container by rail express
Ammunition, chemical, explosive	See § 73.59			
Ammunition material	See § 73.55			
Ammunition non-explosive	See § 73.55			
Ammunition for cannon with empty projectiles	Expl. B	No exemption, 73.89		Not accepted.
Ammunition for cannon with explosive projectiles	Expl. A	No exemption, 73.54		Do.
Ammunition for cannon with gas projectiles	Expl. A	No exemption, 73.54		Do.
Ammunition for cannon with illuminating projectiles	Expl. A	No exemption, 73.54		Do.
Ammunition for cannon with incendiary projectiles	Expl. A	No exemption, 73.54		Do.
Ammunition for cannon with inert-loaded projectiles	Expl. B	No exemption, 73.89		Do.
Ammunition for cannon with smoke projectiles	Expl. A	No exemption, 73.54		Do.
Ammunition for cannon with solid projectiles	Expl. B	No exemption, 73.89		Do.
Ammunition for cannon without projectiles	Expl. B	No exemption, 73.89		Do.
Ammunition, rocket. See Rocket ammunition.				
Ammunition, small-arms. *See* Small-arms ammunition.				
Ammunition for small-arms with explosive bullets	Expl. A	No exemption, 73.58		Not accepted.
Ammunition for small-arms with explosive projectiles	Expl. A	No exemption, 73.58		Do.
*Amyl acetate	F. L.	73.118, 73.119	Red	10 gallons.
Amyl chloride	F. L.	73.118, 73.119	do.	Do.
Amyl mercaptan	F. L.	No exemption, 73.141	Red	10 gallons.
Amyl nitrite	F. L.	73.118, 73.119	do.	Do.
Amyl trichlorosilane	Cor. L.	No exemption, 73.280	White	Do.
∅Anhydrous ammonia	Nonf. G.	73.302, 73.308, 73.314, 73.315	Green	300 pounds.
Anhydrous hydrazine. *See* Hydrazine, anhydrous.				
Anhydrous hydrofluoric acid. *See* Hydrofluoric acid, anhydrous.				
Aniline oil drums, empty	See § 73.347 (d).			
Aniline oil, liquid	Pois. B.	No exemption, 73.347	Poison	55 gallons.
Anisoyl chloride	Cor. L.	73.244, 73.279	White	1 quart.
*Anti-freeze compounds, liquid	F. L.	73.118, 73.119	Red	10 gallons
*Anti-freeze preparations, proprietary, liquid	F. L.	73.118, 73.119	do.	Do.
Antimony pentachloride	Cor. L.	73.244, 73.247	White	1 quart.
Antimony pentachloride, solution	Cor. L.	73.242, 73.245	White	5 pints.
Antimony pentafluoride	Cor. L.	No exemption, 73.246	do.	25 pounds.
Apparatus. See Refrigerating machines, comp. gas or flammable liquid.				
Argon	Nonf. G.	73.302, 73.307, 73.314	Green	300 pounds.
Argon, pressurized liquid	Nonf. G.	No exemption, 73.308	Green	300 pounds.
Arsenate of lead. *See* Lead arsenate.				
Arsenic acid, liquid	Pois. B.	73.345, 73.348	Poison	55 gallons.
Arsenic acid, solid	Pois. B.	73.364, 73.366	do.	200 pounds.
Arsenic bromide, solid	Pois. B.	73.364, 73.365	do.	Do.
Arsenic chloride (arsenous), liquid	Pois. B.	73.345, 73.346	do.	55 gallons.
Arsenic iodide, solid	Pois. B.	73.364, 73.365	do.	200 pounds.
Arsenic pentoxide, solid	Pois. B.	73.364, 73.365	do.	Do.
Arsenic solid	Pois. B.	73.364, 73.366	do.	Do.
Arsenic sulfide (powder), solid	Pois. B.	73.364, 73.365	do.	Do.
Arsenic trichloride, liquid	Pois. B.	73.345, 73.346	do.	55 gallons
Arsenic trioxide, solid (arsenic, white, solid, arsenous acid, solid)	Pois. B.	73.364, 73.366, 73.368	do.	200 pounds.
Arsenic, white, solid	Pois. B.	73.364, 73.366	do.	Do.
Arsenical compounds or mixtures, n. o. s., liquid	Pois. B.	73.345, 73.346	do	55 gallons.
Arsenical compounds or mixtures, n. o. s., solid	Pois. B.	73.364, 73.367	do.	200 pounds.
Arsenical dip, liquid (sheep dip)	Pois. B.	73.345, 73.346	do	55 gallons.
Arsenical dust	Pois. B.	73.364, 73.368	do.	200 pounds
Arsenical flue dust	Pois. B.	73.364, 73.368	do	Do
Arsenous acid, solid	Pois. B.	73.364, 73.365	do.	Do.
Arsenous and mercuric iodide solution, liquid	Pois. B.	73.345, 73.346	do.	55 gallons.
**Asphalt, cut-back. See* *Road asphalt, or tar, liquid.				
Automobiles, motorcycles, tractors or other self-propelled vehicles	See §§ 73.120, 73.303			
Automobiles, motorcycles, tractors or other self-propelled vehicles, engines or other mechanical apparatus, with charged electric storage batteries, wet	See § 73.250			
Bags, nitrate of soda, empty and unwashed	F. S.	No exemption, 73.155 (a)	Yellow	25 pounds.
Barium chlorate	Oxy. M.	73.153, 73.163	do.	100 pounds.
Barium chlorate, wet	Oxy. M.	73.153, 73.163 (a) (6)	do.	200 pounds.
Barium cyanide, solid	Pois. B.	73.370	Poison	Do.
Barium nitrate	Oxy. M.	73.153, 73.182	Yellow	100 pounds.

* See § 72.4. ∅ See § 72.4.

LIST OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES—*Continued*

Article	Classed as	Exemptions and Packing (see sec.)	Label required if not exempt	Maximum quantity in 1 outside container by rail express
Barium perchlorate	Oxy. M	73.153, 73.154	Yellow	100 pounds.
Barium permanganate	Oxy. M	73.153, 73.154	do	Do.
Barium peroxide (*binoxide, dioxide*)	Oxy. M	73.153, 73.156	do	Do.
Barrels, empty. *See* Drums, empty.				
Batteries, dry	Not regulated			
Batteries, electric storage, wet	Cor. L.	73.244 (c) (31), 73.260	White	600 pounds.
Batteries, electric storage, wet, with automobiles, auto parts, engines or other mechanical apparatus	Cor. L.	73.250, 73.260	White	No limit.
Batteries, electric storage, wet, with containers of corrosive battery fluid	Cor. L.	No exemption, 73.258	do	2 gallons.
Battery charger with electrolyte (acid), or alkaline corrosive liquid	Cor. L.	No exemption, 73.259	do	3 quarts.
Battery fluid. *See* Electrolyte (acid) or Alkaline corrosive battery fluid.				
Benzene (benzol)	F. L.	73.118, 73.119	Red	10 gallons.
Benzine	F. L.	73.118, 73.119	do	Do.
Benzol (benzene)	F. L.	73.118, 73.119	do	Do.
Benzoyl chloride	Cor. L.	73.244, 73.247	White	1 quart.
Benzoyl peroxide	Oxy. M	No exemption, 73.157, 73.158	Yellow	25 pounds.
Benzyl bromide. See a-Bromotoluene.				
Benzyl chloride	Cor. L.	73.244, 73.247	White	1 quart.
Benzyl chlorocarbonate. *See* Benzyl chloroformate.				
Benzyl chloroformate	Cor. L.	No exemption, 73.288	White	5 pints.
Beryllium metal powder	Pois. B.	No exemption, 73.378	Poison	25 pounds.
Black blasting powder. *See* Black powder.				
Black pellet powder. *See* Black powder.				
Black powder	Expl. A.	No exemption, 73.60		Not accepted.
Black powder igniters with empty cartridge bags	Expl. C.	No exemption, 73.106		150 pounds.
Black rifle powder. *See* Black powder.				
Blasting caps—1,000 or less	Expl. C.	No exemption, 73.103		See § 73.86.
Blasting caps—more than 1,000	Expl. A.	No exemption, 73.66		Not accepted.
Blasting caps with safety fuse—1,000 or less	Expl. C.	No exemption, 73.103		See § 73.86.
Blasting caps, electric. *See* Electric blasting caps.				
Blasting gelatin. See High explosives.				
Blasting powder. See Black powder.				
*Boiler compound, liquid	Cor. L.	73.244, 73.249	White	10 gallons.
Bombs, explosive. See Explosive bomb.				
Bombs, explosive, with gas, smoke, or incendiary material. See Explosive bomb.				
Bombs, explosive, incendiary. See Explosive bombs.				
Bombs, fireworks. See Special fireworks.				
Bombs, gas, smoke or incendiary, non-explosive. See Chemical ammunition.				
Bombs, incendiary or smoke without bursting charges See Special fireworks				
Bombs, sand-loaded or empty	See § 73.55			
Boosters (explosive)	Expl. A.	No exemption, 73.69		Not accepted.
Bordeaux arsenites, liquid	Pois. B.	73.345, 73.346	Poison	55 gallons.
Bordeaux arsenites, solid	Pois. B.	73.364, 73.365	do	200 pounds.
Boron trichloride	Cor. L.	No exemption, 73.251	White	1 quart.
Boron trifluoride	Nonf. G.	73.302, 73.306	Green	300 pounds.
Bottles, *acid or other corrosive liquids*, empty	See § 73.29			
*Box toe gum	F. L.	73.118, 73.119	Red	10 gallons.
Boxes, reused	See § 73.28			
Bromacetone, liquid	Pois. A.	No exemption, 73.329 (a)	Poison Gas	Not accepted.
Brombenzyl cyanide, liquid	Pois. C.	No exemption, 73.382	Tear Gas	20 pounds.
Bromine	Cor. L.	No exemption, 73.252	White	1 quart.
Bromine pentafluoride	Cor. L.	No exemption, 73.284	do	100 pounds.
Bromine trifluoride	Cor. L.	No exemption, 73.283	do	100 pounds.
a-Bromotoluene	Cor. L.	No exemption, 73.281	do	5 pints.
*Bronze liquid (or paint). *See* *Paint, enamel, lacquer, stain, shellac, varnish, etc.				
Brucine, solid (dimethoxy strychnine)	Pois. B.	73.364, 73.365	Poison	200 pounds.
Burnt cotton (not repicked)	F. S.	No exemption, 73.159	Yellow	Not accepted.
Burnt fiber	F. S.	No exemption, 73.169	do	Do.
Bursters (explosive)	Expl. A.	No exemption, 73.69		Not accepted.
Butadiene, inhibited	F. G.	73.302, 73.306, 73.314	Red Gas	300 pounds.
Butane. See Liquefied petroleum gas.				
*Butyl acetate	F. L.	73.118, 73.119	Red	10 gallons.
*Butyl alcohol. *See* Alcohol or alcohol, n. o. s.				
Butyl mercaptan	F. L.	No exemption, 73.141	Red	10 gallons.
Butyl trichlorosilane	Cor. L.	No exemption, 73.280	White	10 gallons.
Butyraldehyde	F. L.	73.118, 73.119	Red	Do.
Cacodylic acid, solid (dimethylarsenic)	Pois. B.	73.364, 73.365	Poison	200 pounds.
Calcium arsenate, solid	Pois. B.	73.364, 73.367	Poison	200 pounds.
Calcium arsenite, solid	Pois. B.	73.364, 73.365	do	Do.

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* See § 72.4.

LIST OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES—*Continued*

Article	Classed as	Exemptions and Packing (see sec.)	Label required if not exempt	Maximum quantity in 1 outside container by rail express
Calcium chlorate	Oxy. M.	73.153, 73.163	Yellow	100 pounds.
Calcium chlorite	Oxy. M.	No exemption, 73.160	do	Do.
Calcium cyanide. *See* Cyanide of calcium.				
Calcium hypochlorite compounds, dry, containing more than 39 percent available chlorine	Oxy. M.	73.217	Yellow	100 pounds.
Calcium, metallic	F. S.	73.153, 73.154	do	Do.
Calcium, metallic, crystalline	F. S.	No exemption, 73.231	do	25 pounds.
Calcium nitrate	Oxy. M.	73.153, 73.182	do	100 pounds.
Calcium peroxide	Oxy. M.	73.153, 73.156	do	Do.
Calcium permanganate	Oxy. M.	73.153, 73.154	do	Do.
Calcium phosphide	F. S.	No exemption, 73.161	do	25 pounds.
Calcium resinate	F. S.	No exemption, 73.166	do	125 pounds.
Calcium resinate, fused	F. S.	No exemption, 73.166	do	Do.
Cannon primers	Expl. C.	No exemption, 73.107		150 pounds.
Caps, blasting. See Blasting caps.				
Caps, toy. See Toy caps.				
Caprylyl peroxide solution	Oxy. M.	73.153 (b), 73.221	Yellow	1 quart.
Carbolic acid, fused solid. *See* Carbolic acid (phenol), solid.				
Carbolic acid (phenol), liquid, (liquid tar acid containing over 50 percent benzo-phenol)	Pois. B.	73.345, 73.349	Poison	55 gallons.
Carbolic acid (phenol), solid	Pois. B.	73.364, 73.369	do	250 pounds.
Carbon, activated. *See* *Charcoal, activated.				
Carbon bisulfide (disulfide)	F. L.	No exemption, 73.121	Red	Not accepted.
∅Carbon dioxide, liquefied	Nonf. G.	73.302, 73.308, 73.314, 73.315	Green	300 pounds.
Carbon dioxide—nitrous oxide mixture	Nonf. G.	73.302, 73.308	do	Do.
Carbon dioxide—oxygen mixture	Nonf. G.	73.302, 73.306	do	Do.
Carbon monoxide	F. G.	73.302, 73.308	Red Gas	150 pounds.
*Carbon remover, liquid	F. L.	73.118, 73.119	Red	10 gallons.
Carbonyl chloride. See Phosgene.				
Carboys, acid, empty	See § 73.29 (c)			
Carboys, empty. *See* Acid carboys, empty.				
Cartridge bags, empty, with black powder igniters.	Expl. C.	No exemption, 73.106		150 pounds.
Cartridge cases, empty, primed	Expl. C.	No exemption, 73.107		Do.
Case oil. *See* Gasoline, *Naphtha.				
Casinghead gasoline. See Gasoline.				
Casks, empty. *See* Drums, empty.				
Caustic potash, liquid	Cor. L.	73.244, 73.249	White	10 gallons.
Caustic soda, liquid	Cor. L.	73.244, 73.249	do	Do.
*Cement, leather	F. L.	73.118, 73.119	Red	12 gallons.
*Cement, linoleum, tile, wallboard, or container, liquid	F. L.	73.118, 73.132	Red	15 gallons.
*Cement, liquid, n. o. s.	F. L.	73.118, 73.119	do	15 gallons.
*Cement, pyroxylin	F. L.	73.118, 73.132	do	Do.
*Cement, roofing, liquid	F. L.	73.118, 73.119	do	12 gallons.
*Cement, rubber	F. L.	73.118, 73.132	do	15 gallons.
Cesium 137	Pois. D.	73.392, 73.393	Poison Radioactive materials Red	300 curies. See § 73.391(c).
*Charcoal, activated	F. S.	73.162	Yellow #	200 pounds.
Charcoal briquettes	F. S.	73.162		Do.
Charcoal, shell	F. S.	73.162	Yellow #	Do.
Charcoal, wood, ground, crushed, granulated or pulverized	F. S.	73.162	Yellow	Do.
Charcoal, wood, lump	F. S.	73.162	do	100 pounds.
Charcoal screenings, *made from "pinon", wood*	F. S.	73.162	Yellow #	200 pounds.
Charcoal, wood screenings *other than "Pinon" wood screenings*	F. S.	No exemption, 73.162	Yellow	Not accepted.
Charcoal screenings, wet	Not accepted			Do.
Charcoal, wet	Not accepted			Do.
Charged oil well jet perforating guns (*total explosive contents in guns exceeding 15 pounds per motor vehicle*)	Expl. A.	No exemption, 73.53 (u), 73.80		Not accepted.
Charged oil well jet perforating guns (*total explosive contents in guns not exceeding 15 pounds per motor vehicle*)	Expl. C.	No exemption, 73.53 (u), 73.110		Not accepted.
*Chemicals, n. o. s. *See* *Drugs, chemicals, medicines or cosmetics, n. o. s.				
Chemical ammunition (containing class A poisons, liquids, or gases)	Pois. A.	No exemption, 73.330	Poison gas	Not accepted.
Chemical ammunition (containing class B poisons, liquids, or gases)	Pois. B.	73.345, 73.350	Poison	55 gallons.
Chemical ammunition (containing class C poisons, liquids, or solids)	Pois. C.	No exemption, 73.383	Tear Gas	20 pounds.
Chemical ammunition, explosive	See § 73.59			
*Chemical kits	See § 73.286			
Chloracetophenone, gas, liquid, or solid	Pois. C.	No exemption, 73.382	Tear Gas	20 pounds.
Chloracetyl chloride	Cor. L.	No exemption, 73.253	White	1 quart.
*Chlorate and borate mixtures	Oxy. M.	73.153, 73.229	Yellow	100 pounds.

* See § 72.4 ∅ See § 72.4. # See § 72.4

LIST OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES—*Continued*

Article	Classed as	Exemptions and Packing (see sec.)	Label required if not exempt	Maximum quantity in 1 outside container by rail express
•Chlorate and magnesium chloride mixture	Oxy. M	73.153, 73.229	Yellow	100 pounds.
Chlorates, n. o. s.	Oxy. M	73.153, 73.163	do	Do.
Chlorates, n. o. s., wet	Oxy. M	73.153, 73.163 (a) (6)	do	200 pounds.
Chlorate explosives, dry. *See* High explosives.				
Chlorate of potash	Oxy. M	73.153, 73.163	Yellow	100 pounds.
Chlorate of soda	Oxy. M	73.153, 73.163	do	Do.
Chlorate powders. *See* High explosives.				
Chloride of phosphorus. *See* Phosphorus trichloride.				
Chloride of sulfur. *See* Sulfur chloride.				
∅Chlorine	Nonf. G	73.302, 73.308, 73.314, 73.315	Green	150 pounds.
Chlorine trifluoride	Cor. L	No exemption, 73.285	White	100 pounds.
Chlorobenzoyl peroxide (para)	Oxy. M	No exemption, 73.157, 73.158	Yellow	25 pounds.
Chloro-o-toluidine hydrochloride	Pois. B	No exemption, 73.362	Poison	1 quart.
Chlorosulfonic acid	Cor. L	73.244, 73.254	White	1 quart.
Chlorosulfonic acid-sulfur trioxide mixture	Cor. L	73.244, 73.254	White	Do.
Chlorpicrin, liquid	Pois. B	No exemption, 73.357	Poison	24 pounds.
Chlorpicrin, absorbed	Pois. B	No exemption, 73.357	Poison	75 pounds.
Chlorpicrin mixtures (*containing no compressed gas or poisonous liquid, class A*)	Pois. B	No exemption, 73.357	Poison	75 pounds.
Chlorpicrin and methyl chloride mixtures	Pois. A	No exemption, 73.329 (b)	Poison Gas	Not accepted.
Chromic acid	Oxy. M	73.153, 73.164	Yellow	100 pounds.
Chromic acid solution	Cor. L	73.244, 73.245, 73.287	White	1 gallon.
Chromic anhydride. *See* Chromic acid.				
Chromium trioxide. *See* Chromic acid.				
Chromyl chloride	Cor. L	No exemption, 73.244, 73.247	White	1 gallon.
Cigar and cigarette lighter fluid	F. L	73.118, 73.119	Red	10 gallons.
Cigarette loads	Expl. C	No exemption, 73.111		150 pounds.
•Cleaning fluid or liquid	F. L	73.118, 73.119	Red	10 gallons.
Cloud gas cylinders. See Chemical ammunition.				
Coal briquettes, hot	Not accepted			Not accepted.
Coal gas. *See* Hydrocarbon gas, non-liquefied.				
Coal, ground bituminous, sea coal, coal facings, etc.	See § 73.165			
•Coal tar distillate	F. L	73.118, 73.119	Red	10 gallons.
•Coal tar light oil	F. L	73.118, 73.119	do	Do.
•Coal tar naphtha	F. L	73.118, 73.119	do	Do.
•Coal tar oil	F. L	73.118, 73.119	do	Do.
•Coating solution	F. L	73.118, 73.132	Red	15 gallons.
Cobalt 60	Pois. D	73.392, 73.393	Poison. Radioactive materials Red	300 curies. See § 73.391(c).
Cobalt resinate, precipitated	F. S	No exemption, 73.166	Yellow	125 pounds.
Cocculus, solid (*fish berry*)	Pois. B	73.364, 73.365	Poison	200 pounds.
Coke, hot	Not accepted			Not accepted.
Collodion	F. L	73.118, 73.119	Red	10 gallons.
Collodion cotton, wet. *See* Wet nitrocellulose.				
Cologne spirits (*alcohol*)	F. L	73.118, 73.119	Red	10 gallons.
Colored fire. *See* Common fireworks.				
Columbian spirits (*wood alcohol*)	F. L	73.118, 73.119	Red	10 gallons.
Combination fuzes	Expl. C	No exemption, 73.105		150 pounds.
Combination primers	Expl. C	No exemption, 73.107		Do.
Commercial shaped charges. *See* High explosives.	See § 73.65 (h)			
Common fireworks	Expl. C	No exemption, 73.100 (r), 73.108		200 pounds.
•Compounds, cleaning, liquid	Cor. L	73.244, 73.245	White	1 quart.
•Compounds, cleaning, liquid (containing hydrochloric (muriatic) acid)	Cor. L	73.244, 73.263	White	10 pints.
•Compounds, cleaning, liquid	F. L	73.118, 73.119	Red	10 gallons.
Compounds, cleaning, liquid (*Containing hydrofluoric acid*)	Cor. L	73.244, 73.256	White	10 pints.
•Compounds, enamel	F. L	73.118, 73.128	Red	55 gallons.
•Compounds, iron or steel rust preventing or removing	Cor. L	73.244, 73.245	White	1 gallon.
•Compounds, lacquer, paint, or varnish, etc., removing, reducing or thinning, liquid	F. L	73.118, 73.128	Red	55 gallons.
•Compounds, lacquer, paint, or varnish removing, liquid	Cor. L	73.244, 73.245	White	1 gallon.
•Compounds, polishing, liquid	F. L	73.118, 73.129	Red	55 gallons.
•Compounds, tree or weed killing, liquid	F. L	73.118, 73.119	Red	10 gallons.
•Compounds, tree or weed killing, liquid	Pois. B	73.345, 73.346	Poison	55 gallons.
•Compounds, tree or weed killing, solid	Oxy. M	73.153, 73.154, 73.229	Yellow	100 pounds.
•Compounds, type-cleaning, liquid	F. L	73.118, 73.119	Red	10 gallons.
•Compounds, vulcanizing, liquid	Cor. L	73.244, 73.245	White	1 quart.
•Compounds, vulcanizing, liquid	F. L	73.118, 73.119	Red	10 gallons.
Compressed gases, n. o. s.	Nonf. G	73.302, 73.306, 73.307, 73.308	Green	300 pounds.
Compressed gases, n. o. s.	F. G	73.302, 73.306, 73.307	Red Gas	Do.
Containers, empty. *See* Acid carboys, empty; bottles empty, drums empty, cylinders empty	See § 73.29			
Containers, reused	See § 73.28			

• See § 72.4. ∅ See § 72.4.

LIST OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES—*Continued*

Article	Classed as	Exemptions and Packing (see sec.)	Label required if not exempt	Maximum quantity in 1 outside container by rail express
Copper acetoarsenite, solid (*emerald green, imperial green, Kings green, moss green, meadow green, mitis green, parrot green, Vienna green*)	Pois. B.	73.364, 73.367	Poison	200 pounds.
Copper arsenite, solid (*Scheele's green, cupric green, copper orthoarsenite, Swedish green*)	Pois. B.	73.364, 73.365	Poison	200 pounds
Copper cyanide	See § 73.370			
Cordeau detonant fuse	Expl. C.	No exemption, 73.104		300 pounds.
Corrosive battery fluid. *See* Electrolyte acid or alkaline battery fluid.				
Corrosive liquid, n. o. s.	Cor. L.	73.244, 73.245	White	1 quart.
Cotton, burnt. *See* Burnt cotton.				
Cotton waste, oily *with more than 5 percent of animal or vegetable oil*	F. S.	No exemption, 73.167	Yellow	Not accepted.
Crotonaldehyde	F. L.	73.118, 73.119	Red	10 gallons.
•Crude nitrogen fertilizer solution	Nonf. G.	73.302, 73.306, 73.314	Green	300 pounds.
•Crude oil, petroleum	F. L.	73.118, 73.119	Red	10 gallons.
Cumene hydroperoxide	Oxy. M.	73.153 (b), 73.224	Yellow	1 quart.
Cupriethylene-diamine solution	Cor. L.	73.244, 73.249	White	1 gallon.
Cyanide of calcium or cyanide of calcium mixtures, solid	Pois. B.	73.370 (c) and (d)	Poison	200 pounds.
Cyanides of copper, zinc, lead, and silver	See § 73.370			
Cyanides or cyanide mixtures, dry	Pois. B.	73.364, 73.370	Poison	200 pounds.
Cyanide of potassium, liquid	Pois. B.	73.345, 73.352	do.	55 gallons.
Cyanide of potassium, solid	Pois. B.	73.370	do.	200 pounds.
Cyanide of sodium, liquid	Pois. B.	73.345, 73.352	do.	55 gallons.
Cyanide of sodium, solid	Pois. B.	73.370	do.	200 pounds.
Cyanogen chloride containing less than 0.9 percent water	Pois. A.	No exemption, 73.328	Poison Gas	Not accepted.
Cyanogen gas	Pois. A.	No exemption, 73.328	do.	Do.
Cyclohexane	F. L.	73.118, 73.119	Red	10 gallons.
Cyclohexenyl trichlorosilane	Cor. L.	No exemption, 73.280	White	10 gallons.
Cyclohexyltrichlorosilane	Cor. L.	No exemption, 73.280	White	10 gallons.
Cyclopentane	F. L.	73.118, 73.119	Red	Do.
Cyclopentane, methyl	F. L.	73.118, 73.119	do.	Do.
Cyclopropane	F. G.	73.302, 73.308	Red Gas	300 pounds.
Cyclotrimethylenetrinitramine, desensitized. See High Explosives.				
Cyclotrimethylenetrinitramine, wet with not less than 10 percent of water. See High explosives.				
Cylinders, empty	See § 73.29			
Delay electric igniters	Expl. C.	No exemption, 73.106		150 pounds.
Depth bombs. See Explosive bomb.				
Detonating fuzes, class A explosives	Expl. A.	No exemption, 73.69		Not accepted.
Detonating fuzes, class A explosives, radioactive	Expl. A.	No exemption, 73.69		Not accepted.
Detonating fuzes, class C explosives	Expl. C.	No exemption, 73.113		150 pounds.
Detonating primers	Expl. A.	No exemption, 73.68		Not accepted.
Diazodinitrophenol. See Initiating explosive.				
Dichlorethylene	F. L.	73.118, 73.119	Red	10 gallons.
ØDichlorodifluoromethane	Nonf. G.	73.302, 73.306, 73.314, 73.315	Green	300 pounds.
ØDichlorodifluoromethane-dichlorotetrafluoroethane mixture	Nonf. G.	73.302, 73.306, 73.314, 73.315	Green	300 pounds.
ØDichlorodifluoromethane-monochlorodifluoromethane mixture	Nonf. G.	73.302, 73.306, 73.314	Green	300 pounds.
ØDichlorodifluoromethane-trichloromonofluoromethane-monochlorodifluoromethane mixture	Nonf. G.	73.302, 73.306, 73.314	Green	300 pounds.
ØDichlorodifluoromethane-trichlorotrifluoroethane mixture	Nonf. G.	73.302, 73.306, 73.314	Green	300 pounds.
•Dichlorodifluoromethane-monofluorotrichloromethane mixture	Nonf. G.	73.302, 73.314, 73.315	Green	300 pounds.
Dichlorodifluoromethane and difluoroethane mixture (*constant boiling mixture*)	Nonf. G.	73.302, 73.308, 73.314	Green	300 pounds.
Dicumyl peroxide	Oxy. M.	73.153, 73.154	Yellow	25 pounds.
Dicumyl peroxide, 50% solution	Oxy. M.	73.153 (b), 73.224	Yellow	1 quart.
Diethyl dichlorosilane	Cor. L.	No exemption, 73.280	White	10 gallons.
Diethylamine	F. L.	73.118, 73.119	Red	10 gallons.
Diethylene glycol dinitrate	See § 73.51 (d)			
Difluoroethane	F. G.	73.302, 73.308, 73.314	Red Gas	300 pounds.
Difluoromonochloroethane	F. G.	73.302, 73.308, 73.314	do.	Do.
Difluorophosphoric acid, anhydrous	Cor. L.	No exemption, 73.275	White	1 gallon.
Dimethylamine, anhydrous	F. G.	73.302, 73.308, 73.314, 73.315	Red Gas	300 pounds.
Dimethylamine, aqueous solution	F. L.	73.118, 73.119	Red	10 gallons.
Dimethyldichlorosilane	F. L.	No exemption, 73.135	Red	10 gallons.
Dimethyl ether	F. G.	73.302, 73.306, 73.314	Red Gas	300 pounds.
Dimethylhydrazine, unsymmetrical	F. L.	No exemption, 73.145	Red	5 pints.
Dimethyl sulfate	Cor. L.	No exemption, 73.255	White	1 quart.
Dimethyl sulfide	F. L.	73.118, 73.119	Red	10 gallons.
Dinitrobenzol, solid	Pois. B.	73.364, 73.371	Poison	200 pounds.
Dinitrobenzol, liquid	Pois. B.	73.345, 73.346	do.	55 gallons.
Dinitrochlorbenzol, solid (*dinitrochlorobenzene*)	Pois. B.	73.364, 73.365	do.	200 pounds.

• See § 72.4. Ø See § 72.4.

LIST OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES—*Continued*

Article	Classed as	Exemptions and Packing (see sec.)	Label required if not exempt	Maximum quantity in 1 outside container by rail express
Diphenyl dichlorosilane	Cor. L.	No exemption, 73.280	White	10 gallons.
Diphenylaminechlorarsine, gas, liquid or solid	Pois. C.	No exemption, 73.382	Tear Gas	20 pounds.
Diphenylchlorarsine, solid	Pois. C.	No exemption, 73.382	do	Do.
Diphosgene. *See* Phosgene.				
Dispersant gas, n. o. s.	Nonf. G.	73.302, 73.306, 73.314	Green	300 pounds.
*Distillate	F. L.	73.118, 73.119	Red	10 gallons.
Dodecyltrichlorosilane	Cor. L.	No exemption, 73.280	White	Do.
*Dressing, leather	F. L.	73.118, 73.119	Red	10 gallons.
*Driers, paint, varnish, enamel, etc. *See* *Paint driers, liquid.				
Drill cartridges	See § 73.55			
*Drugs, chemicals, medicines or cosmetics, n. o. s.	F. L.	73.118, 73.119	Red	10 gallons.
*Drugs, chemicals, medicines or cosmetics, n. o. s.	F. S.	73.153, 73.154	Yellow	100 pounds.
*Drugs, chemicals, medicines or cosmetics, n. o. s.	Oxy. M.	73.153, 73.154	do	Do.
*Drugs, chemicals, medicines or cosmetics, n. o. s.	Cor. L.	73.244, 73.245	White	1 quart.
*Drugs, chemicals, medicines or cosmetics, n. o. s. (liquid)	Pois. B.	73.345, 73.346	Poison	55 gallons.
*Drugs, chemicals, medicines or cosmetics, n. o. s. (solid)	Pois. B.	73.364, 73.365	do	200 pounds.
Drums, empty	See § 73.29			
Dummy cartridges	See § 73.55			
Dusts, by-product, poisonous. *See* Arsenical dust.				
Dynamite. See High explosives.				
Electric blasting caps—more than 1,000	Expl. A.	No exemption, 73.66		Not accepted.
Electric blasting caps—1,000 or less	Expl. C.	No exemption, 73.103		See § 73.86.
Electric squibs	Expl. C.	No exemption, 73.106		150 pounds.
Electric storage batteries, wet. *See* Batteries, electric storage, wet.				
Electrolyte (acid), battery fluid	Cor. L.	73.244, 73.257	White	5 gallons.
Electrolyte (acid) or alkaline corrosive battery fluid packed with storage batteries	Cor. L.	No exemption, 73.258	do	2 gallons.
Electrolyte (acid) or alkaline corrosive battery fluid packed with battery charger, radio current supply device or parts thereof, or electronic equipment	Cor. L.	No exemption, 73.259	do	6 quarts.
Empty cartridge bags with black powder igniters	Expl. C.	No exemption, 73.106		150 pounds.
Empty cartridge cases, primed	Expl. C.	No exemption, 73.107		Do.
*Enamel. *See* *Paint, enamel, lacquer, stain, shellac, varnish, etc.				
Engines, internal combustion	See § 73.120			
*Eradicators, paint or grease, liquid	F. L.	73.118, 73.119	Red	10 gallons.
Ethane	F. G.	73.302, 73.308	Red Gas	300 pounds.
Ether	F. L.	73.118, 73.119	Red	10 gallons.
Ether, ethyl (*sulfuric*). *See* Ether.				
Ethyl acetate	F. L.	73.118, 73.119	Red	10 gallons.
Ethyl alcohol. *See* Alcohol or alcohol, n. o. s.				
Ethyl aldehyde. *See* Acetaldehyde.				
Ethyl chloride	F. L.	No exemption, 73.123	Red	300 pounds in cylinders, 15 pounds in other containers.
Ethyl chlorocarbonate. *See* Ethyl chloroformate.				
Ethyl chloroformate	Cor. L.	No exemption, 73.288	White	5 pints.
Ethyldichloroarsine	Pois. A.	No exemption, 73.328	Poison Gas	Not accepted.
Ethyl dichlorosilane	F. L.	No exemption, 73.135	Red	10 gallons.
∅Ethylene	F. G.	73.302, 73.308	Red Gas	300 pounds.
Ethylene dichloride	F. L.	73.118, 73.119	Red	10 gallons.
Ethylene imine, inhibited	F. L.	No exemption, 73.139	Red	5 pints.
Ethylene oxide	F. L.	No exemption, 73.124	do	300 pounds in cylinders, 15 pounds in other containers.
Ethyl formate	F. L.	73.118, 73.119	Red	10 gallons.
Ethyl mercaptan	F. L.	No exemption, 73.141	Red	10 gallons.
Ethyl methyl ether	F. L.	73.118, 73.119	Red	Do.
Ethyl methyl ketone	F. L.	73.118, 73.119	do	Do.
Ethyl nitrate (*nitric ether*)	F. L.	73.118, 73.119	do	Do.
Ethyl nitrite (*nitrous ether*)	F. L.	73.118, 73.119	do	Do.
Ethyl phenyl dichlorosilane	Cor. L.	No exemption, 73.280	White	Do.
Ethyl trichlorosilane	F. L.	No exemption, 73.135	Red	Do.
Explosive auto alarms	Expl. C.	No exemption, 73.111		150 pounds.
Explosive bomb	Expl. A.	No exemption, 73.56		Not accepted.
Explosive cable cutters	Expl. C.	No exemption, 73.102		150 pounds.
Explosives, class A	See § 73.53			
Explosives, class B	See § 73.88			

∅ See § 72.4 * See § 72.4.

LIST OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES—*Continued*

Article	Classed as	Exemptions and Packing (see sec.)	Label required if not exempt	Maximum quantity in 1 outside container by rail express
Explosives, class C	See § 73.100			
Explosive compositions	Expl. A or B	No exemption, 73.53, 73.61 to 73.93		10 pounds.
Explosive mine	Expl. A	No exemption, 73.56		Not accepted.
Explosive projectile	Expl. A	No exemption, 73.56		Do.
Explosive release device	Expl. C	No exemption, 73.102		150 pounds.
Explosive rivets	Expl. C	No exemption, 73.100 (q)		150 pounds.
Explosive samples for laboratory examination	See § 73.86			
Explosive torpedo	Expl. A	No exemption, 73.56		Not accepted.
*Extracts, liquid, flavoring	F. L.	73.118, 73.119	Red	10 gallons.
Fabrics or fibers *with animal or vegetable oil. See* Fibers or fabrics *with animal or vegetable oil.*				
Felt waste, wet. *See* Waste wool, wet.				
Ferric arsenate, solid	Pois. B	73.364, 73.365	Poison	200 pounds.
Ferric arsenite, solid	Pois. B	73.364, 73.365	do	Do.
Ferrous arsenate (*iron arsenate*), solid	Pois. B	73.364, 73.365	do	Do.
*Fertilizer ammoniating solution *containing free ammonia.*	Nonf. G	73.302, 73.306, 73.314	Green	300 pounds.
Fertilizer, tankage. *See* Garbage, tankage.				
Fiber, burnt	F. S	No exemption, 73.169	Yellow	Not accepted.
Fibers or fabrics, with animal or vegetable oil	F. S	No exemption, 73.170	do	Do.
Film, motion-picture and toy pieces of. See Motion-picture film, toy and motion-picture film scrap.				
Firecrackers. See Common fireworks or Special fireworks.				
Firecracker salutes. See Common fireworks or Special fireworks.				
Fire extinguisher actuating cartridges	Expl. C	73.114		150 pounds.
Fire extinguisher charges	Cor L	73.261	White	1 gallon.
Fire extinguisher charges containing not to exceed 50 grains of propellant explosives per unit	See § 73.88 (f) Note 1.			
Fire extinguishers	Nonf. G	73.310	Green	300 pounds.
Fireworks, common	Expl. C	No exemption, 73.100 (r), 73.108.		200 pounds.
Fireworks, exhibition display pieces. See Special fireworks.				
Fireworks, special	Expl. B	No exemption, 73.88 (d), 73.91	Special Fireworks ##.	200 pounds.
Fish meal. *See* Fish scrap or fish meal.				
Fish scrap or fish meal *containing less than 6 percent or more than 12 percent moisture*	F. S	No exemption, 73.153 (c) (16), 73.171.	Yellow	Not accepted.
*Flame retardant compound, liquid	Cor. L	73.244, 73.291	White	10 gallons.
Flammable liquids, n. o. s	F. L	73.118, 73.119	Red	Do.
Flammable solids, n. o. s	F. S	73.153, 73.154	Yellow	25 pounds.
Flares. See Common fireworks.				
Flares, aeroplane. See Special fireworks.				
Flash cartridges. See Special fireworks and Low explosives.				
Flash crackers. See Common fireworks or Special fireworks.				
Flash powder. See Special fireworks and Low explosives.				
Flash sheets. See Special fireworks and Low explosives.				
Flue dust, poisonous	Pois. B	73.364, 73.368	Poison	200 pounds.
Fluorine	F. G	73.302, 73.311	Red Gas	6 pounds.
Fluosulfonic acid	Cor. L	No exemption, 73.274	White	10 pints.
Formic acid	Cor. L	73.244, 73.245, 73.289	do	5 gallons.
Formic acid, solution	Cor. L	73.244, 73.245, 73.289	White	5 gallons.
Fulminate of mercury, dry	Forbidden explosive.			Forbidden explosive.
Fulminate of mercury, wet. See Initiating explosive.				
**Fumigants*	See § 73.152 (a) Note 1.			
*Furniture polish. *See* *Polishes, metal, stove, furniture, and wood, liquid.				
*Furniture or wood stains, liquid. *See* *Paint, enamel, lacquer, stain, shellac, varnish, etc.				
Fuse igniters	Expl. C	No exemption, 73.106		150 pounds.
Fuse, instantaneous. See Instantaneous fuse.				
Fuse lighters	Expl. C	No exemption, 73.106		150 pounds.
Fuse, safety. See Safety fuse.				
Fusees. See Railway or highway fusees.				
Fuzes, combination	Expl. C	No exemption, 73.105		150 pounds.

* See § 72.4. ## See § 72.4.

LIST OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES—*Continued*

Article	Classed as	Exemptions and Packing (see sec.)	Label required if not exempt	Maximum quantity in 1 outside container by rail express
Fuzes, detonating, class A explosives	Expl. A	No exemption, 73.69		Not accepted.
Fuzes, detonating, class A explosives, radioactive	Expl. A	No exemption, 73.69		Not accepted.
Fuzes, detonating, class C explosives	Expl. C	No exemption, 73.113		150 pounds.
Fuzes, percussion	Expl. C	No exemption, 73.105		150 pounds.
Fuzes, time	Expl. C	No exemption, 73.105		Do.
Fuzes, tracer	Expl. C	No exemption, 73.105		Do.
Garbage tankage *containing less than 8 percent of moisture.*	F. S.	No exemption, 73.153 (c) (49), 73.209.	Yellow	Not accepted.
Gas cylinders, empty	See § 73.29			
*Gas drips, hydrocarbon	F. L.	73.118, 73.119	Red	10 gallons.
Gas identification sets	Pois. A. and C.	No exemption, 73.331	Poison Gas	See § 73.331.
Gasoline	F. L.	73.118, 73.119	Red	10 gallons.
Gelatine dynamite. See High explosives.				
Gold 198	Pois. D	73.392, 73.393	Poison Radioactive materials. Red	See § 73.391 (c).
*Gold paint. *See* *Paint, enamel, lacquer, stain, shellac, varnish, etc.				
Grenades, empty, primed	Expl. C.	No exemption, 73.107		150 pounds.
Grenades, hand. See Hand grenades.				
Grenades, hand or rifle, explosive, with gas, smoke or incendiary material. See Hand or Rifle grenades.				
Grenades, hand or rifle. with gas, smoke or incendiary material but without bursting charges	See §§ 73.88(d), 73.330, 73.350.			
Grenades, police. See Police grenades, poison gas, class A.				
Grenades, rifle. See Rifle grenades.				
Grenades, tear gas. See Tear gas grenades.				
Guanidine nitrate	Oxy. M	73.153, 73.182	Yellow	100 pounds.
Guanyl nitrosamino guanylidene hydrazine. See Initiating explosive.				
Guanyl nitrosamino guanyl tetrazene. See Initiating explosive.				
Guided missiles with war heads. See Explosive projectiles.				
Guided missiles without war heads. See Propellant explosive, class B.				
Guncotton. See High explosives.				
Hafnium metal powder or sponge, dry	F. S.	No exemption, 73.215	Yellow	75 pounds.
Hafnium metal powder, wet or sludge	F. S.	No exemption, 73.214	Yellow	150 pounds.
Hair, wet	F. S.	No exemption, 73.172	Yellow	Not accepted.
Hand grenades	Expl. A	No exemption, 73.56		Do.
Hand signal devices	Expl. C.	No exemption, 73.100 (y), 73.108		200 pounds.
Heaters for refrigerator cars, liquid fuel type	F. L.	73.146		
Helium	Nonf. G	73.302, 73.307, 73.314	Green	300 pounds.
Helium—oxygen mixture	Nonf. G	73.302, 73.307	do	Do.
Heptane	F. L.	73.118, 73.119	Red	10 gallons.
Hexadecyltrichlorosilane	Cor. L.	No exemption, 73.280	White	10 gallons.
Hexaethyl tetraphosphate and compressed gas mixture	Pois. A	No exemption, 73.334	Poison gas	Not accepted.
Hexaethyl tetraphosphate, liquid	Pois. B.	No exemption, 73.358	Poison	1 quart.
Hexaethyl tetraphosphate mixture, dry	Pois. B.	73.377	Poison	200 pounds.
Hexaethyl tetraphosphate mixture, liquid	Pois. B.	73.359	Poison	1 quart.
Hexafluorophosphoric acid	Cor. L	No exemption, 73.275	White	1 gallon.
Hexamethylene diamine solution	Cor. L.	73.244, 73.249, 73.292	do	10 gallons.
Hexane	F. L.	73.118, 73.119	Red	Do.
Hexyl trichlorosilane	Cor. L.	No exemption, 73.280	White	Do.
High explosives	Expl. A	No exemption, 73.61 to 73.87		See § 73.86.
High explosives, liquid	Expl. A	No exemption, 73.62		Not accepted.
Highway fusees	Expl. C.	No exemption, 73.100 (y), 73.108		200 pounds.
High wines. See Alcohol or alcohol, n. o. s.				
Hydrazine, anhydrous	Cor. L	No exemption, 73.276	White	5 pints.
Hydrazine solution containing 50 percent or less of water	Cor. L	No exemption, 73.276	do	Do.
Hydriodic acid	Cor. L	73.244, 73.245	do	1 gallon.
Hydrobromic acid	Cor. L.	73.244, 73.262	do	Do.
Hydrobromic acid, anhydrous. *See* Hydrogen bromide.				
Hydrocarbon gas, liquefied	F. G	73.302, 73.306, 73.314	Red Gas	300 pounds.
Hydrocarbon gas, nonliquefied	F. G	73.302, 73.307	do	Do.
Hydrochloric (*muriatic*) acid	Cor. L	73.244, 73.263	White	10 pints.
Hydrochloric acid, anhydrous. *See* Hydrogen chloride.				

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* See § 72.4.

LIST OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES—*Continued*

Article	Classed as	Exemptions and Packing (see sec.)	Label required if not exempt	Maximum quantity in 1 outside container by rail express
Hydrochloric acid mixtures	Cor. L.	73.244, 73.263	White	10 pints.
Hydrocyanic acid, liquefied	Pois. A	No exemption, 73.332	Poison Gas	Not accepted
Hydrocyanic acid (*prussic*), liquid	Pois. A	No exemption, 73.332	do	Do.
Hydrocyanic acid (*prussic*), unstabilized	Not accepted			Do.
Hydrocyanic acid solutions	Pois. B	No exemption, 73.351	Poison	25 pounds.
Hydrochloric acid solution, inhibited	Cor. L.	73.244, 73.263	White	10 pints.
Hydrofluoric acid	Cor. L.	73.244, 73.264 (a)	White	10 pints.
Hydrofluoric acid, anhydrous	Cor. L.	No exemption, 73.264 (b)	do	110 pounds.
Hydrofluoric and sulfuric acids, mixtures. *See* Mixtures of hydrofluoric and sulfuric acids.				
Hydrofluosilicic acid	Cor. L.	73.244, 73.265	White	10 pints.
Ø Hydrogen	F. G.	73.302, 73.307, 73.314	Red Gas	300 pounds.
Hydrogen bromide	Nonf. G.	73.302, 73.306	Green	300 pounds.
Hydrogen chloride	Nonf. G.	73.302, 73.306, 73.308	do	Do.
Hydrogen, liquefied	Not accepted			Not accepted.
Hydrogen peroxide (*hydrogen dioxide*) *solution in water containing over 8 percent hydrogen peroxide by weight*	Cor. L.	73.244, 73.266	White	1 gallon.
Hydrogen sulfide	F. G.	73.302, 73.308, 73.314	Red Gas	300 pounds.
Hypochlorite solutions containing more than 7 percent available chlorine by weight	Cor. L.	No exemption, 73.277	White	4 gallons.
Igniter cord	Expl. C.	No exemption, 73.100 (s)		150 pounds.
Igniters	Expl. C.	No exemption, 73.106		150 pounds.
Igniters, jet thrust (*jato*), class A explosives	Expl. A.	No exemption, 73.79	None	Not accepted.
Igniters, jet thrust (*jato*), class B explosives	Expl. B.	No exemption, 73.92	None	200 pounds.
Illuminating projectiles fuzed or not fuzed, with expelling charges *See* Special fireworks.				
Inflammable liquids, n. o. s. *See* Flammable liquids, n. o. s.				
Inflammable solids, n. o. s. *See* Flammable solids, n. o. s.				
Initiating explosive	Expl. A.	No exemption, 73.70 to 73.78, incl.		Not accepted.
Diazodinitrophenol		No exemption, 73.70		
Fulminate of mercury		No exemption, 73.71		
Guanyl nitrosamino guanylidene hydrazine		No exemption, 73.72		
Lead azide, dextrinated type only		No exemption, 73.73		
Lead mononitroresorcinate		No exemption, 73.70		
Lead styphnate (*lead trinitroresorcinate*)		No exemption, 73.74		
Nitro mannite		No exemption, 73.75		
Nitrosoguanidine		No exemption, 73.76		
Pentaerythrite tetranitrate		No exemption, 73.77		
Tetrazene (*guanyl nitrosamino guanyl tetrazene*)		No exemption, 73.78		
*Ink	F. L.	73.118, 73.144	Red	10 gallons.
*Insecticide, dry	Pois. B.	73.364, 73.365	Poison	200 pounds.
*Insecticide, liquid	Pois. B	73.345, 73.346	do	55 gallons.
Insecticide, liquefied gas	Nonf. G.	73.302, 73.306, 73.308	Green	300 pounds.
*Insecticide, liquid (*vermin exterminator*)	F. L.	73.118, 73.119	Red	10 gallons.
Instantaneous fuse	Expl. C.	No exemption, 73.100 (m)		150 pounds.
Iodine monochloride	Cor. L.	No exemption, 73.293	White	1 quart.
Iridium 192	Pois. D.	73.392, 73.393	Poison Radioactive materials Red	300 curies. See § 73.391 (c).
Iron mass, spent	F. S.	No exemption, 73.174	Yellow	Not accepted.
Iron sponge *not properly oxidized*	F. S.	No exemption, 73.174	do	Do.
Iron sponge, spent	F. S.	No exemption, 73.174	do	Do.
Isobutane. *See* Liquefied petroleum gas.				
Isobutylene. *See* Liquefied petroleum gas.				
Isooctane	F. L.	73.118, 73.119	Red	10 gallons.
Isooctene	F. L.	73.118, 73.119	do	Do.
Isopentane	F. L.	73.118, 73.119	do	Do.
Isoprene	F. L.	73.118, 73.119	do	Do.
*Isopropanol	F. L.	73.118, 73.119	do	Do.
Isopropyl acetate	F. L.	73.118, 73.119	Red	10 gallons.
Isopropyl mercaptan	F. L.	No exemption, 73.141	Red	10 gallons.
Isopropyl percarbonate, stabilized	Cor. L.	No exemption, 73.282	White	Not accepted.
Isopropyl percarbonate, unstabilized	F. S.	No exemption, 73.218	Yellow	Not accepted.
Jet thrust igniters. *See* Igniters, jet thrust.				
Jet thrust unit (*jato*) class A explosives	Expl. A.	No exemption, 73.79		Not accepted.
Jet thrust unit (*jato*) class B explosives	Expl. B.	No exemption, 73.92		Do.
Kegs, reused	See §73.28			

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* See § 72.4. Ø See § 72.4.

LIST OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES—*Continued*

Article	Classed as	Exemptions and Packing (see sec.)	Label required if not exempt	Maximum quantity in 1 outside container by rail express
*Lacquer. *See* *Paint, enamel, lacquer, stain, shellac, varnish, etc.				
*Lacquer base, liquid. *See* *Paint, enamel, lacquer, stain, shellac, varnish, etc.				
*Lacquer base or lacquer chips, dry	F. S.	73.153, 73.175	Yellow	100 pounds.
*Lacquer base or lacquer chips, plastic (*wet with alcohol or solvent*)	F. L.	73.118, 73.127	Red	25 pounds.
*Lacquer removing, reducing and thinning compounds. *See* *Compounds, lacquer, paint, or varnish removing, reducing, or thinning, liquid.				
Lauroyl peroxide	Oxy. M	73.153 (b), 73.157, 73.158	Yellow	25 pounds.
Lead arsenate, solid	Pois. B	73.364, 73.367	Poison	200 pounds.
Lead arsenite, solid	Pois. B	73.364, 73.365	do	Do.
Lead azide. See Initiating explosive.				
Lead cyanide	See § 73.370			
Lead mononitroresorcinate. See Initiating explosive.				
Lead nitrate	Oxy. M	73.153, 73.182,	Yellow	100 pounds.
Lead styphnate (*lead trinitroresorcinate*). *See* Initiating explosive.				
*Leather bleach	F. L.	73.118, 73.119	Red	10 gallons.
*Leather dressing	F. L.	73.118, 73.119	do	Do.
Lewisite	Pois. A	No exemption, 73.328	Poison Gas	Not accepted.
ØLiquefied carbon dioxide. *See* Carbon dioxide, liquefied.				
Liquefied hydrocarbon gas	F. G.	73.302, 73.306, 73.314	Red Gas	300 pounds.
Liquefied nonflammable gases *charged with nitrogen, carbon dioxide, or air*	Nonf. G	73.302, 73.308	Green	30 pounds.
ØLiquefied petroleum gas	F. G.	73.302, 73.312, 73.314, 73.315.	Red Gas	300 pounds.
Liquids other than those classified as flammable, corrosive, or poisonous charged with nitrogen, carbon dioxide or air. See Compressed gases, n. o. s.				
Lithium aluminum hydride	F. S.	No exemption, 73.206	Yellow	25 pounds.
Lithium aluminum hydride, ethereal	F. L	No exemption, 73.137	Red	1 quart.
Lithium amide, powdered	F. S.	73.153, 73.168	Yellow	100 pounds.
Lithium hydride	F. S	No exemption, 73.206	do	25 pounds.
Lithium hypochlorite compounds, dry, containing more than 39 percent available chlorine	Oxy. M.	73.217	Yellow	100 pounds.
Lithium metal	F. S	No exemption, 73.206	do	25 pounds.
Lithium metal, in cartridges	See § 73.206			
Lithium peroxide	Oxy. M	73.153 (a), 73.154	Yellow	100 pounds.
Lithium silicon	F. S	No exemption, 73.206	do	25 pounds.
London purple, solid	Pois. B	73.364, 73.365	Poison	200 pounds.
Low explosives	Expl. A	No exemption, 73.60		Not accepted.
Low blasting explosives. See Low explosives.				
Machines or apparatus	See §§ 73.130, 73.313.			
Magnesium arsenate, solid	Pois. B	73.364, 73.367	Poison	200 pounds.
Magnesium dross	See § 73.173			
Magnesium, metallic, powdered	F. S	73.153, 73.154	Yellow	100 pounds.
Magnesium nitrate	Oxy. M	73.153, 73.182	do	Do.
Magnesium perchlorate	Oxy. M	73.153, 73.154	do	Do.
Magnesium peroxide, solid	Oxy. M	73.153, 73.154	do	100 pounds.
Magnesium scrap, (borings, clippings, shavings, sheets, or turnings)	F. S.	73.153, 73.220	do	100 pounds.
Matches, block. See Strike-anywhere matches	F. S	No exemption, 73.176	do	50 pounds.
Matches, book. card, or strike-on-box, *with other articles*	See § 73.176 (g)			
Matches, book, card, or strike-on-box	See § 73.176 (g)			
Matches, strike-anywhere	F. S	No exemption, 73.176	Yellow	50 pounds.
*Medicines, n. o. s. *See* *Drugs, chemicals, medicines, or cosmetics, n. o. s.				
Mercuric acetate	Pois. B	73.364, 73.365	Poison	200 pounds.
Mercuric-ammonium chloride, solid	Pois. B	73.364, 73.365	do	Do.
Mercuric benzoate, solid	Pois. B	73.364, 73.365	do	Do.
Mercuric bromide, solid	Pois. B	73.364, 73.365	do	Do.
Mercuric cyanide, solid	Pois. B	73.370	do	Do.
Mercuric iodide, solid	Pois. B	73.364, 73.365	do	Do.
Mercuric iodide solution	Pois. B	73.345, 73.346	do	55 gallons
Mercuric oleate, solid	Pois B	73.364, 73.365	do	200 pounds.
Mercuric oxide (red), solid	Pois. B	73.364, 73.365	do	Do.
Mercuric oxide (yellow), solid	Pois. B	73.364, 73.365	do	Do.
Mercuric oxycyanide, solid	Pois. B	73.364, 73.365	do	Do.
Mercuric-potassium cyanide, solid	Pois. B	73.364, 73.365, 73.370	do	Do.
Mercuric-potassium iodide. solid	Pois. B	73.364, 73.365	do	Do.

* See § 72.4. Ø See § 72.4.

LIST OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES—*Continued*

Article	Classed as	Exemptions and Packing (see sec.)	Label required if not exempt	Maximum quantity in 1 outside container by rail express
Mercuric salicylate, solid	Pois. B	73.364, 73.365	Poison	200 pounds.
Mercuric subsulfate, solid	Pois. B	73.364, 73.365	do	Do.
Mercuric sulfate, solid	Pois. B	73.364, 73.365	do	Do.
Mercuricyanamid, solid	Pois. B	73.364, 73.365	do	Do.
Mercuric sulfo cyanate, solid	Pois. B	73.364, 73.365	do	Do.
Mercurol (*mercury nucleate*), solid	Pois. B	73.364, 73.365	do	Do.
Mercurous bromide, solid	Pois. B	73.364, 73.365	do	Do.
Mercurous gluconate, solid	Pois. B	73.364, 73.365	do	Do.
Mercurous iodide, solid	Pois. B	73.364, 73.365	do	Do.
Mercurous nitrate, solid	Pois. B	73.364, 73.365	do	Do.
Mercurous oxide, black, solid	Pois. B	73.364, 73.365	do	Do.
Mercurous sulfate, solid	Pois. B	73.364, 73.365	do	Do.
Mercury acetate, solid	Pois. B	73.364, 73.365	do	Do.
Mercury bichloride, solid	Pois. B	73.364, 73.372	do	Do.
Mercury bisulfate, solid	Pois. B	73.364, 73.365	do	Do.
Mercury compounds, n. o. s. (solid)	Pois. B	73.364, 73.365	do	Do.
Mercury cyanide, solid	Pois. B	73.370	do	Do.
Mercury fulminate. See Initiating explosive.				
Metal kegs, reused	See § 73.28			
*Metal polish. *See* *Polishes, metal, stove, furniture and wood, liquid.				
Metallic sodium or potassium. *See* Sodium or potassium, metallic.				
Methanol (*methyl alcohol*). *See* Alcohol, wood.				
Methane	F. G	73.302, 73.306	Red Gas	300 pounds.
Methyl acetate	F. L	73.118, 73.119	Red	10 gallons.
Methyl acetone	F. L	73.118, 73.119	do	Do.
Methyl bromide and ethylene dibromide mixture, liquid	Pois. B	73.353	Poison	55 gallons.
Methyl bromide, liquid (*bromomethane*)	Pois. B	No exemption, 73.353	Poison	55 gallons.
∅Methyl chloride	F. G	73.302, 73.308, 73.314, 73.315	Red Gas	300 pounds
Methyl chloroformate	Cor. L	No exemption, 73.288	White	5 pints.
Methylchloromethyl ether, anhydrous	F. L	No exemption, 73.143	Red	Not accepted.
Methyldichlorarsine	Pois. A	No exemption, 73.328	Poison Gas	Not accepted.
Methyl dichlorosilane	F. L	No exemption, 73.136	Red	10 gallons.
Methyl ethyl ketone	F. L	73.118, 73.119	Red	10 gallons.
Methyl formate	F. L	73.118, 73.119	Red	10 gallons.
Methyl hydrate. *See* Alcohol or alcohol, n. o. s.				
Methylhydrazine	F. L	No exemption, 73.145	Red	5 pints.
Methyl iso-propenyl ketone, inhibited	F. L	73.118, 73.119	Red	10 gallons.
Methyl mercaptan	F. G	73.302, 73.308, 73.314	Red Gas	300 pounds.
Methyl methacrylate monomer	F. L	73.118, 73.119	Red	10 gallons.
Methyl parathion, liquid	Pois. B	No exemption, 73.358	Poison	1 quart.
Methyl parathion mixture, dry	Pois. B	73.377	Poison	200 pounds.
Methyl parathion mixture, liquid	Pois. B	73.359	Poison	1 quart.
Methyltrichlorosilane	F. L	No exemption, 73.135	Red	10 gallons.
Methyl vinyl ketone, inhibited	F. L	73.147	Red	10 gallons.
Mine rescue equipment	See §§ 73.302 (a) (2) and 76 703(d)			
Mines, empty	See § 73.55			
Mines, explosive. See Explosive mine.				
Mixed acid. *See* Nitrating (mixed) acid.				
Mixtures of hydrofluoric and sulfuric acids	Cor. L	No exemption, 73.290	White	10 pints.
Mixtures or solutions of liquefied nonflammable gases and liquids other than those classified as flammable, corrosive, or poisonous charged with nitrogen, carbon dioxide, or air. See Compressed gases, n. o. s.				
Monochloracetone, stabilized	Pois. C	No exemption, 73.384	Tear Gas	5 gallons.
Monochloracetone (unstabilized)	Not accepted			Not accepted.
Monochloroacetic acid, liquid	Cor. L	73.244, 73.294	White	1 quart.
Monochlorodifluoromethane	Nonf. G	73.302, 73.308, 73.314, 73.315	Green	300 pounds.
Monochloroethylene. *See* Vinyl chloride.				
Monochloropentafluoroethane	Nonf. G	73.302, 73.308	Green	300 pounds.
Monochlorotetrafluoroethane	Nonf. G	73.302, 73.306, 73.314	Green	300 pounds.
Monochlorotrifluoromethane	Nonf. G	73.302, 73.308	do	Do.
Monofluorophosphoric acid, anhydrous	Cor. L	No exemption, 73.275	White	1 gallon.
Monomethylamine, anhydrous	F. G	73.302, 73.308, 73.314, 73.315	Red Gas	300 pounds.
Monomethylamine, aqueous solution	F. L	73.118, 73.119	Red	10 gallons.
*Mortar stain, liquid	F. L	73.118, 73.128	do	55 gallons.
∅Motion-picture film, *nitrocellulose base, including mixed shipments with nonflammable film*	F. S	No exemption, 73.177	Yellow	200 pounds.
Motion-picture film, old and wornout (*nitrocellulose*)	F. S	No exemption, 73.178	do	Do.
Motion-picture film, old and wornout (*slow-burning*)	See § 73.181 (a) (1).			

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* See § 72.4. ∅ See § 72.4.

LIST OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES—*Continued*

Article	Classed as	Exemptions and Packing (see sec.)	Label required if not exempt	Maximum quantity in 1 outside container by rail express
ØMotion-picture outfits, toy	See § 73.181 (a) (4).			
ØMotion-picture film (*processed, positive or negative, nitrocellulose*)	F. S.	No exemption, 73.177	Yellow	200 pounds.
ØMotion-picture film (*processed, positive or negative, slow-burning*)	See § 73.181 (a) (1).			
Motion-picture film scrap (*nitrocellulose*), samples of	F. S.	No exemption, 73.196	Yellow	25 pounds.
Motion-picture film scrap (*nitrocellulose*), *other than samples*	F. S.	No exemption, 73.195	do	Not accepted.
Motion-picture film scrap (*slow-burning*)	See § 73.181 (a) (2).			
ØMotion-picture film, toy (*nitrocellulose*)	F. S.	No exemption, 73.179	Yellow	200 pounds.
ØMotion-picture film, toy (*slow-burning*)	See § 73.181 (a) (1).			
ØMotion-picture film, toy pieces (*nitrocellulose*)	See § 73.181 (a) (3).			
Motion-picture film, unexposed (*nitrocellulose base*).	F. S.	73.180	Yellow ##	250 pounds.
Motion-picture film, unexposed (*slow-burning*)	See § 73.181 (a) (1).			
Motorcycles	See § 73.120			
Motor fuel antiknock compound	Pois. B.	No exemption, 73.354	Poison	55 gallons.
*Motor fuel, n. o. s.	F. L.	73.118, 73.119	Red	10 gallons.
Motors, internal combustion	See § 73.120			
Muriatic acid. *See* Hydrochloric acid				
Mustard gas	Pois. A.	No exemption, 73.328	Poison Gas	Not accepted.
*Naphtha	F. L.	73.118, 73.119	Red	10 gallons.
*Naphtha distillate	F. L.	73.118, 73.119	do	Do.
*Naphtha, petroleum. *See* *Petroleum naphtha.				
*Naphtha, solvent	F. L.	73.118, 73.119	Red	10 gallons.
Natural gasoline. See Gasoline.				
Negative cotton. See High explosives.				
Neohexane	F. L.	73.118, 73.119	Red	10 gallons.
Neon gas	Nonf. G.	73.302, 73.307	Green	300 pounds.
New explosives or explosive devices	See §§ 73.51 (q), 73.86, and 74.502 (a) (8).			
Nickel carbonyl	F. L.	No exemption, 73.126	Red	Not accepted.
*Nickel catalyst, finely divided, activated or spent	F. S.	No exemption, 73.233	Yellow	100 pounds.
Nickel cyanide, solid	Pois. B.	73.370	Poison	200 pounds.
Nicotine hydrochloride	Pois. B.	73.345, 73.346	do	55 gallons.
Nicotine, liquid	Pois. B.	73.345, 73.346	do	Do.
Nicotine salicylate	Pois. B.	73.364, 73.365	Poison	200 pounds.
Nicotine sulfate, liquid	Pois. B.	73.345, 73.346	do	55 gallons.
Nicotine sulfate, solid	Pois. B.	73.364, 73.365	do	200 pounds.
Nicotine tartrate	Pois. B.	73.364, 73.365	do	Do.
Nitrate of aluminum. *See* Aluminum nitrate.				
Nitrate of ammonia. *See* Ammoninum nitrate.				
Nitrate of ammonia explosives. See High explosives.				
Nitrate of ammonia fertilizer. See Ammonium nitrate fertilizer, containing 90 percent or more ammonium nitrate with no organic coating.				
Nitrate of barium. *See* Barium nitrate.				
Nitrate of lead. *See* Lead nitrate.				
Nitrate of potash. *See* Potassium nitrate.				
Nitrate of soda. *See* Sodium nitrate.				
Nitrate of soda and potash	Oxy. M.	73.153, 73.182	Yellow	100 pounds.
Nitrate of soda bags, empty, unwashed. *See* Bags, nitrate of soda, empty and unwashed.				
Nitrate of strontia. *See* Strontium nitrate.				
Nitates, n. o. s.	Oxy. M	73.153, 73.182	Yellow	100 pounds.
Nitrating (mixed) acid	Cor. L.	No exemption, 73.267	White	2½ pints.
Nitric acid	Cor. L.	No exemption, 73.268	do	5 pints.
Nitric oxide	Pois. A.	No exemption, 73.337	Poison Gas	Not accepted.
Nitrite of soda. *See* Sodium nitrite.				
Nitrobenzol, liquid (*oil of mirbane*)	Pois. B.	73.345, 73.346	Poison	55 gallons.
Nitro carbo nitrate	Oxy. M.	73.153, 73.182	Yellow	100 pounds.
Nitrocellulose, colloided, granular, or flake, wet with alcohol or solvent. See Wet nitrocellulose colloided, granular or flake—20 percent alcohol or solvent.				
Nitrocellulose, colloided, granular, or flake, wet with 20 percent water. See Wet nitrocellulose, colloided, granular or flake—20 percent water.				

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* See § 72.4. ## See § 72.4. Ø See § 72.4

LIST OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES—*Continued*

Article	Classed as	Exemptions and Packing (see sec.)	Label required if not exempt	Maximum quantity in 1 outside container by rail express
Nitrocellulose (collodion cotton), wet with water. See Wet nitrocellulose—20 percent water.				
Nitrocellulose (collodion cotton), wet with alcohol or solvent. See Wet nitrocellulose—30 percent alcohol or solvent.				
Nitrocellulose, dry. See High explosives.				
Nitrochlorbenzene, ortho, liquid	Pois. B.	73.345, 73.346	Poison	55 gallons.
Nitrochlorbenzene, meta or para, solid	Pois. B.	73.364, 73.374	do	200 pounds.
Nitrogen	Nonf. G.	73.302, 73.307, 73.314	Green	300 pounds.
Nitrogen dioxide, liquid	Pois. A.	No exemption, 73.336	Poison Gas	Not accepted.
*Nitrogen fertilizer solution	Nonf. G.	73.302, 73.306, 73.314	Green	300 pounds.
Nitrogen peroxide (*tetroxide*)	Pois. A.	No exemption, 73.336	Poison Gas	Not accepted
Nitrogen, pressurized liquid	Nonf. G	No exemption, 73.308	Green	300 pounds.
Nitroglycerin, liquid	See § 73.51 (d)			
Nitroglycerin liquid, desensitized. See High Explosive, liquid.				
Nitroglycerin, spirits of. *See* Spirits of nitroglycerin.				
Nitrohydrochloric acid	Cor. L.	No exemption, 73.278	White	5 pints.
Nitrohydrochloric acid, diluted	Cor. L.	do	do	Do.
Nitro mannite. See Initiating explosive.				
Nitroguanidine, dry. See High explosives.				
Nitroguanidine, wet with water. See Wet nitroguanidine—20 percent water.				
Nitrosoguanidine. See Initiating explosive.				
Nitrostarch, dry. See High explosives.				
Nitrostarch, wet with alcohol or solvent. See Wet nitrostarch—30 percent alcohol or solvent.				
Nitrostarch, wet with water. See Wet nitrostarch—20 percent water.				
Nitrosylchloride	Nonf. G.	73.302, 73.308, 73.314	Green	300 pounds.
Nitrourea. See High explosives.				
ØNitrous oxide	Nonf. G.	73.302, 73.308, 73.315	Green	300 pounds.
Nitroxylol	Pois. B.	73.345, 73.346	Poison	55 gallons.
Nonliquefied gases. See Compressed gases, n. o. s.				
Nonliquefied hydrocarbon gas	F. G	73.302, 73.307	Red Gas	300 pounds.
Nonyl trichlorosilane	Cor. L.	No exemption, 73.280	White	10 gallons.
Octadecyltrichlorosilane	Cor. L.	No exemption, 73.280	White	10 gallons.
Octyl trichlorosilane	Cor. L.	No exemption, 73.280	White	10 gallons.
*Oil, *described as* oil, oil, n. o. s., petroleum oil, or petroleum oil, n. o. s.	F. L.	73.118, 73.119	Red	Do.
Oil of vitriol. See Sulfuric acid.				
Oil well cartridges	Expl. C.	No exemption, 73.112		150 pounds.
Oleum. See Sulfuric acid.				
Oxide, spent. *See* Spent oxide.				
Oxidizing material, n. o. s.	Oxy. M	73.153, 73.154	Yellow	25 pounds.
Oxidizing materials with other articles—fumigants.	See § 73.152 (a) Note 1.			
ØOxygen	Nonf. G.	73.302, 73.307, 73.314	Green	300 pounds.
Oxygen, pressurized liquid	Nonf. G.	No exemption, 73.308	Green	300 pounds.
*Paint driers, liquid	F. L.	73.118, 73.128	Red	55 gallons.
*Paint, enamel, lacquer, stain, shellac, varnish, aluminum, bronze, gold, wood filler, liquid, and lacquer base liquid	F. L.	73.118, 73.128	Red	55 gallons.
*Paint, lacquer and varnish removing, reducing or thinning compounds. *See* *Compounds, lacquer, paint, or varnish, reducing or thinning liquid, etc.				
Paper cap ammunition for toy pistols. See Toy caps.				
Paper caps. See Toy caps.				
Paper stock, wet	F. S.	No exemption, 73.185	Yellow	Not accepted.
Paper waste, wet. *See* Waste paper, wet.				
Para chlorobenzoyl peroxide. *See* Chlorobenzoyl peroxide, (para).				
Paranitraniline (paranitroaniline), solid	Pois. B.	73.364, 73.373	Poison	200 pounds.
Parathion and compressed gas mixture	Pois. A.	No exemption, 73.334	Poison Gas	Not accepted.
Parathion, liquid	Pois. B.	No exemption, 73.358	Poison	1 quart.
Parathion, mixture, dry	Pois. B.	73.377	Poison	200 pounds.
Parathion mixture, liquid	Pois. B.	73.359	Poison	1 quart.
Paris green, solid	Pois. B.	73.364, 73.367	Poison	200 pounds.
Pentaborane	F. L.	No exemption, 73.138	Red	Not accepted.
Pentane	F. L.	73.118, 73.119	Red	10 gallons.

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* See § 72.4. Ø See § 72.4.

LIST OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES—*Continued*

Article	Classed as	Exemptions and Packing (see sec.)	Label required if not exempt	Maximum quantity in 1 outside container by rail express
Pentane, methyl	F. L.	73.118, 73.119	Red	10 gallons.
Pentaerythrite tetranitrate. *See* Initiating explosive.				
Pentolite, dry. *See* High explosives.				
Peracetic acid	Oxy. M.	73.223	Yellow	5 pints.
Perchlorate of ammonia. *See* Ammonium perchlorate.				
Perchlorate of potash. *See* Potassium perchlorate.				
Perchlorates, n. o. s.	Oxy. M.	73.153, 73.154	Yellow	100 pounds.
Perchloric acid *in excess of 72 percent*	See § 73.269			
Perchloric acid *not in excess of 72 percent*	Cor. L.	73.244, 73.269	White	7 pounds.
Perchloro-methyl-mercaptan	Pois. B.	73.345, 73.360	Poison	10 pounds.
Percussion caps	Expl. C.	No exemption, 73.107		150 pounds.
Percussion fuzes	Expl. C.	No exemption, 73.105		Do.
Permanganate of potash	Oxy. M.	73.153, 73.154, 73.194	Yellow	100 pounds.
Permanganate of soda	Oxy. M.	73.153, 73.154	do	Do.
Permanganates, n. o. s.	Oxy. M.	73.153, 73.154	do	Do.
Peroxide of sodium. *See* Sodium peroxide.				
Peroxides, organic, liquids, n. o. s.	F. L.	No exemption, 73.119 (m)	Red	1 quart.
Peroxides, organic, liquids, n. o. s.	Oxy. M.	73.153, 73.221	Yellow	Do.
Petroleum, crude. *See* Crude oil.				
*Petroleum distillate	F. L.	73.118, 73.119	Red	10 gallons.
Petroleum ether	F. L.	73.118, 73.119	do	Do.
Petroleum gas, liquefied. *See* Liquefied petroleum gas.				
*Petroleum naphtha	F. L.	73.118, 73.119	Red	10 gallons.
Phenol. *See* Carbolic acid.				
Phenylcarbylamine chloride	Pois. A.	No exemption, 73.328	Poison Gas	Not accepted.
Phenyldichlorarsine, liquid	Pois. B.	No exemption, 73.355	Poison	30 gallons.
Phenyl trichlorosilane	Cor. L.	No exemption, 73.280	White	10 gallons.
Phosgene (*diphosgene*)	Pois. A.	No exemption, 73.333	Poison Gas	Not accepted.
Phosphoric anhydride	F. S.	No exemption, 73.188	Yellow	100 pounds.
Phosphorus, amorphous, red	F. S.	No exemption, 73.189	do	11 pounds.
Phosphorus oxychloride	Cor. L.	No exemption, 73.271	White	1 quart.
Phosphorus pentachloride	F. S.	No exemption, 73.191	Yellow	5 pounds.
Phosphorus sesquisulfide	F. S.	No exemption, 73.225	Yellow	11 pounds.
Phosphorus tribromide	Cor. L.	No exemption, 73.270	White	1 quart.
Phosphorus trichloride	Cor. L.	No exemption, 73.271	do	Do.
Phosphorus, white or yellow, dry	F. S.	No exemption, 73.190 (d) and (e)	Yellow	Not accepted.
Phosphorus, white or yellow, in water	F. S.	No exemption, 73.190 (b) and (c)	do	25 pounds.
Photographic film scrap, X-ray film scrap	F. S.	No exemption, 73.195	do	See § 73.196.
Photographic flash powder. *See* Special fireworks or low explosives.				
Picrates, dry. *See* High explosives.				
Picrate of ammonia. *See* High explosives.				
Picric acid, dry. *See* High explosives.				
Picric acid, wet, not exceeding 16 ounces	See § 73.192			
Picric acid, wet, with not less than 10 percent water, over 25 pounds. *See* High explosives.				
Picric acid, wet, with not less than 10 percent water, *in excess of 16 ounces but not exceeding 25 pounds*	F. S.	No exemption, 73.193	Yellow	25 pounds.
Pinwheels. *See* Common fireworks.				
*Plastic solvent, n. o. s.	F. L.	73.118, 73.119	Red	10 gallons.
Poisonous liquid or gas, n. o. s.	Pois. A.	No exemption, 73.328	Poison Gas	Not accepted.
Poisonous liquids, n. o. s.	Pois. B.	73.345, 73.346	Poison	55 gallons.
Poisonous liquids, n. o. s.	Pois. C.	No exemption, 73.382	Tear Gas	75 pounds.
Poisonous solids, n. o. s.	Pois. B	73.364, 73.365	Poison	200 pounds.
Poisonous solids, n. o. s	Pois. C	No exemption, 73.382	Tear Gas	75 pounds.
Police grenades, poison gas, class A	Pois. A	No exemption, 73.335	Poison Gas	Not accepted.
*Polishes, metal, stove, furniture and wood, liquid	F. L.	73.118, 73.129	Red	55 gallons.
**Polymerizable materials*	See § 73.21 (b)			
Potash, caustic, solution. *See* Caustic potash, liquid.				
Potassium arsenate, solid	Pois. B	73.364, 73.365	Poison	200 pounds.
Potassium arsenite, solid	Pois. B	73.364, 73.365	do	Do.
Potassium bromate	Oxy. M	73.153, 73.154	Yellow	100 pounds.
Potassium chlorate (*potash chlorate*). *See* Chlorate of potash.				
Potassium cyanide. *See* Cyanide of potassium.				
Potassium hydroxide solution. *See* Caustic potash, liquid.				
Potassium, metallic	F. S	No exemption, 73.206	Yellow	25 pounds.
Potassium, metallic liquid alloy	F. S.	No exemption, 73.202	do	1 pound.

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* See § 72.4.

LIST OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES—*Continued*

Article	Classed as	Exemptions and Packing (see sec.)	Label required if not exempt	Maximum quantity in 1 outside container by rail express
Potassium nitrate	Oxy. M	73.153, 73.182	Yellow	100 pounds.
Potassium nitrate mixed (fused) with sodium nitrite	Oxy. M	73.153, 73.183	do	Do
Potassium nitrite	Oxy. M	73.153, 73.154	do	100 pounds.
Potassium perchlorate	Oxy. M	73.153, 73.219	do	Do.
Potassium permanganate. *See* Permanganate of potash.				
Potassium peroxide	Oxy. M	No exemption, 73.154	Yellow	100 pounds.
Potassium sulfide	F. S.	73.153, 73.207	do	300 pounds.
Potato spray (*arsenical*), liquid. *See* *Insecticide, liquid.				
Primers. See Cannon, combination, or small-arm primers.				
Primers, detonating. See Detonating primers.				
Projectiles, explosive. See Explosive projectile.				
Projectiles, gas, nonexplosive. See Chemical Ammunition, class A, B, or C.				
Projectiles, gas, smoke, or incendiary, with burster or booster with or without detonating fuse. See Explosive projectile.				
Projectiles, illuminating, incendiary or smoke with expelling charge but without bursting charge. See Special fireworks.				
Projectiles, sand-loaded, empty, or solid	See § 73.55			
Propane. See Liquefied petroleum gas.				
Propellant explosives, class A explosives	Expl. A.	No exemption, 73.64 (d)		See § 73.86.
Propellant explosives, class B explosives	Expl. B.	No exemption, 73.93	Red #	10 pounds.
Propellant explosives in water (*smokeless powder for cannon or small arms*)	Expl. B.	No exemption, 73.93		Not accepted.
Propellant explosives in water unstable, condemned or deteriorated (*smokeless powder for cannon or small arms*)	Expl. B.	No exemption, 73.93		Not accepted.
Propylene oxide	F. L.	73.118, 73.119	Red	10 gallons.
Propyl mercaptan	F. L.	No exemption, 73.141	Red	10 gallons.
Propyl trichlorosilane	Cor. L.	No exemption, 73.280	White	10 gallons.
Propylene. See Liquefied petroleum gas.				
Prussic acid. See Hydrocyanic acid.				
*Pyridine	F. L.	73.118, 73.119	Red	10 gallons.
Pyroforic fuel	F. L.	No exemption, 73.134	Red	Not accepted.
Pyro sulfuryl chloride	Cor. L.	73.244, 73.247	White	1 quart.
*Pyroxylin cement. *See* Cement, pyroxylin.				
Pyroxylin plastic scrap	F. S.	No exemption, 73.195, 73.196	Yellow	See § 73.196.
Pyroxylin plastics, rods, sheets, rolls, tubes	F. S.	73.197	Yellow ##	350 pounds.
*Pyroxylin solution	F. L.	73.118, 73.119	Red	10 gallons.
*Pyroxylin solvent, n. o. s	F. L.	73.118, 73.119	do	Do.
Radio battery chargers	See § 73.259			
Radio current supply devices	See § 73.259			
Radioactive materials, n. o. s.	Pois. D.	73.392, 73.393, 73.394	Poison Radioactive materials (Blue or Red.)	See §73.391 (b) and (c).
Rags, oily	F. S.	No exemption, 73.153 (c) (38), 73.199.	Yellow	Not accepted.
Rags, wet	F. S	No exemption, 73.200	do	Do.
Railway fusees	Expl. C.	No exemption, 73.100(y), 73.108		200 pounds.
Railway torpedoes	Expl. B.	No exemption, 73.91	Special Fireworks##	200 pounds.
*Reducing compounds, paint, varnish, lacquer, etc. *See* *Compounds, lacquer, paint, or varnish, etc., removing, reducing or thinning, liquid.				
Refrigerant gas, n. o. s.				
Refrigerating machines	See § 73.130, 73.313.			
*Removing compounds, paint, varnish, lacquer, etc. *See* *Compounds, lacquer, paint, or varnish, etc., removing, reducing or thinning, liquid.				
*Resin solution	F. L.	73.118, 73.119	Red	55 gallons.
Resinate of cobalt, precipitated. *See* Cobalt resinate, precipitated.				
Rifle grenades	Expl. A	No exemption, 73.56		Not accepted.
Rifle powder. See Black powder.				
*Road asphalt or tar, liquid	F. L.	73.118, 73.131	Red	10 gallons.
Rocket ammunition with empty projectiles	Expl. B	No exemption, 73.90		Not accepted.
Rocket ammunition with explosive projectiles	Expl. A	No exemption, 73.57		Do.

See § 72.4. # See § 72.4. * See § 72.4.

LIST OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES—*Continued.*

Article	Classed as	Exemptions and Packing (see sec.)	Label required if not exempt	Maximum quantity in 1 outside container by rail express
Rocket ammunition with illuminating projectiles.	Expl. A	No exemption, 73.57		Not accepted.
Rocket ammunition with gas projectiles	Expl. A	No exemption, 73.57		Do.
Rocket ammunition with incendiary projectiles	Expl. A	No exemption, 73.57		Do.
Rocket ammunition with inert-loaded projectiles.	Expl. B	No exemption, 73.90		Do.
Rocket ammunition with smoke projectiles	Expl. A	No exemption, 73.57		Do.
Rocket ammunition with solid projectiles	Expl. B	No exemption, 73.90		Do.
Rocket ammunition without projectiles	Expl. B	No exemption, 73.90		Do.
Rocket fireworks. See Common fireworks.				
Rocket heads. See Explosive projectiles.				
Roman candles. See Common fireworks.				
Rough ammoniate tankages	F. S	No exemption, 73.153 (c) (50), 73.210.	Yellow	Do
*Rubber cement. *See* *Cement, rubber.				
*Rubber scrap or rubber buffings	F. S	73.153, 73.201	Yellow	10 pounds.
*Rubber shoddy, regenerated rubber, or reclaimed rubber.	F. S	73.153, 73.201	do	Do.
*Rum, denatured	F. L	73.118, 73.119	Red	10 gallons.
Safety fuse	See § 73.100 (o)			
Safety squibs	Expl. C	No exemption, 73.106		150 pounds.
Saltpeter. *See* Potassium nitrate.				
Saltpeter, Chile. *See* Sodium nitrate.				
Salutes. See Common fireworks and Special fireworks.				
Samples of explosives	See § 73.86			
Samples, New explosives	See § 73.86			
Samples of explosives and explosive articles	See § 73.86			
Scheele's green. See Copper arsenite.				
Self-propelled vehicles	See § 73.120			
Shaped charges. commercial. See High explosives	See § 73.65 (h)			
*Shellac. *See* *Paint, enamel, lacquer, stain, shellac, varnish, etc.				
Shellac, liquid	F. L	73.118, 73.128	Red	55 gallons.
Shells, fireworks. See Common fireworks or Special fireworks.				
Ship distress signals. See Special fireworks.				
Signal flares	Expl. C	No exemption, 73.100 (y), 73.108		200 pounds.
Silicon chloride (*tetrachloride*)	Cor. L	73.244, 73.247	White	1 gallon
Silver cyanide	See § 73.370			
Silver nitrate	Oxy. M	73.153, 73.182	Yellow	100 pounds.
*Sludge acid	Cor. L	No exemption, 73.248	White	1 quart.
Small-arms ammunition	Expl. C	No exemption, 73.101		150 pounds.
Small-arms ammunition, tear gas cartridges	Expl. C	No exemption, 73.101	Tear gas	Do.
Small-arms primers	Expl. C	No exemption, 73.107		Do.
Smoke candles	Expl. C	No exemption, 73.100 (y), 73.108		200 pounds.
Smoke generators. See Chemical ammunition, class B or C.				
Smoke pots	Expl. C	No exemption, 73.100 (y), 73.108		200 pounds.
Smoke signals	Expl. C	No exemption, 73.100 (y), 73.108		200 pounds.
Smokeless powder for cannon or small arms. See Propellant explosives or High explosives.				
Smoke projectiles with bursting charges. See Explosive projectile.				
Smoke projectiles with expelling charge but without bursting charge. See Special fireworks.				
Soda amatol. See High explosives.				
Soda, caustic solution. *See* Caustic soda, liquid.				
Sodium aluminate, liquid	Cor. L	73.244, 73.249	White	10 gallons.
Sodium amide	F. S	No exemption, 73.206	Yellow	25 pounds.
Sodium azide	Pois B	73.364, 73.375	Poison	200 pounds.
Sodium bromate	Oxy. M	73.153, 73.154	Yellow	100 pounds.
Sodium arsenate, solid	Pois. B	73.364, 73.365, 73.368	Poison	200 pounds.
Sodium arsenite (solution), liquid	Pois. B	73.345, 73.346	do	55 gallons.
Sodium cacodylate, solid (*sodium dimethyl arsenate*)	Pois. B	73.364, 73.365	do	200 pounds.
Sodium chlorate (*soda chlorate*)	Oxy. M	73.153, 73.163	Yellow	100 pounds.
Sodium chlorite	Oxy. M	No exemption, 73.160	do	Do.
Sodium chlorite solution (not exceeding 40 percent sodium chlorite)	Cor. L	73.244, 73.263	White	4 gallons.
Sodium cyanide. *See* Cyanide of sodium.				
Sodium hydride	F. S	No exemption, 73.198	Yellow	25 pounds.
Sodium hydrosulfite	F. S	73.153, 73.204	do	100 pounds.
Sodium hydroxide solution. *See* Caustic soda, liquid.				

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* See § 72.4.

LIST OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES—*Continued*

Article	Classed as	Exemptions and Packing (see sec.)	Label required if not exempt	Maximum quantity in 1 outside container by rail express
Sodium, metallic	F. S.	No exemption, 73.206	Yellow	25 pounds.
Sodium, metallic, dispersion in organic solvent	F. S.	No exemption, 73.230	do	10 pounds.
Sodium, metallic liquid alloy	F. S	No exemption, 73.202	Yellow	1 pound.
Sodium methylate, dry	F. S.	73.153, 73.154	Yellow	100 pounds
*Sodium methylate, alcohol mixture	F. L.	73.118, 73.119	Red	10 gallons.
Sodium nitrate	Oxy. M	73.153, 73.182	Yellow	100 pounds
Sodium nitrite	Oxy. M	73.153, 73.154, 73.234	do	Do.
Sodium nitrite mixed (fused) with potassium nitrate	Oxy. M	73.153, 73.183	do	Do.
Sodium permanganate	Oxy. M	73.153, 73.154	Yellow	100 pounds
Sodium peroxide	Oxy. M	No exemption, 73.187	do	Do.
Sodium picramate wet with 20 per cent of water	F. S	No exemption, 73.205	do	25 pounds.
Sodium potassium alloys	F. S.	No exemption, 73.206	Yellow	25 pounds.
*Sodium sulfide	F. S.	73.153, 73.207	do	300 pounds.
Solvents, n. o. s.	F. L.	73.118, 73.119	Red	15 Gallons.
**Sparklers.* *See* Common fireworks.				
Special fireworks	Expl. B	No exemption, 73.88 (d), 73.91	Special Fireworks ##	200 pounds.
Spent iron mass. *See* Iron mass, spent.				
Spent iron sponge. *See* Iron sponge, spent.				
Spent mixed acid	Cor. L	No exemption, 73.248	White	1 quart.
Spent oxide	F. S	No exemption, 73.174	Yellow	Not accepted
Spent sulfuric acid	Cor. L	No exemption, 73.248	White	1 quart.
Spirits of nitroglycerin	F. L	73.133	Red	6 quarts
Sporting powder. *See* Black powder or Propellant explosives, class B explosives.				
Spreader cartridges. *See* Special fireworks.				
Squibs, electric or safety. *See* Electric squibs or Safety squibs.				
*Stain. *See* *Paint, enamel, lacquer, stain, shellac, varnish, etc.				
Starter cartridges, jet engine, class B explosives	Expl. B	No exemption, 73.92		200 pounds.
Storage batteries, wet. *See* Batteries, electric storage, wet.				
Stores, ship or vessels	See § 71.9			
*Stove polish. *See* *Polishes, metal, stove, furniture and wood, liquid.				
Strike-anywhere matches. *See* Matches, strike-anywhere.				
Strike-on-box matches. *See* Matches, strike-on-box.				
Strontium arsenite, solid	Pois. B	73.364, 73.365	Poison	200 pounds.
Strontium chlorate	Oxy. M	73.153, 73.163	Yellow	100 pounds.
Strontium chlorate, wet	Oxy. M	73.153, 73.163 (a) (6)	do	200 pounds.
Strontium nitrate	Oxy. M	73.153, 73.182	Yellow	100 pounds.
Strontium peroxide	Oxy. M	73.153 (a), 73.154	Yellow	100 pounds.
Strychnine and salts thereof, solid	Pois. B	73.364, 73.365	Poison	200 pounds.
Styphnate of lead. *See* Initiating explosive.				
Succinic acid peroxide	Oxy. M	73.153 (b), 73.157, 73.158	Yellow	25 pounds.
Sulfide of sodium. *See* Sodium sulfide.				
Sulfide of potassium. *See* Potassium sulfide.				
Sulfur chloride (*mono and di*)	Cor. L	No exemption, 73.247	White	1 gallon.
∅Sulfur dioxide	Nonf. G	73.302, 73.308, 73.314, 73.315	Green	300 pounds.
Sulfur hexafluoride	Nonf. G	73.302, 73.308	do	Do.
Sulfur trioxide, stabilized	Cor. L	73.244, 73.273	White	1 gallon.
Sulfuric acid (*oil of vitriol*)	Cor. L	73.244, 73.272	do	10 pints.
Sulfuric acid, *fuming* (*oleum*) (*Nordhausen*). *See* Sulfuric acid.				
Sulfuryl chloride	Cor. L	73.244, 73.247	White	1 quart.
Supplementary charges (explosive)	Expl. A	No exemption, 73.69		Not accepted
Tankage. *See* Garbage tankage.				
Tankage fertilizers	F. S.	No exemption, 73.153 (c) (49), 73.209.	Yellow	Not accepted
Tankages, rough ammoniate	F. S.	No exemption, 73.153 (c) (50), 73.210.	do	Do.
Tank car, containing residual phosphorus and filled with water	See § 73.232			
Tank cars, gas (must not contain gases that combine chemically)	See § 73.301 (a)			
Tank truck, empty	See § 73.29			
Tanks, empty	See § 73.29			
*Tar, liquid	F. L.	73.118, 73.131	Red	10 gallons.
Tear gas candles	Pois. C	No exemption, 73.385	Tear Gas	75 pounds.
Tear gas cartridges. *See* Small-arms ammunition tear gas cartridges.				
Tear gas grenades	Pois. C	No exemption, 73.385	Tear Gas	75 pounds.
Tear gas material, liquid or solid, n. o. s.	Pois. C	No exemption, 73.382	do	Do.

* See § 72.4. ## See § 72.4.

LIST OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES—*Continued*

Article	Classed as	Exemptions and Packing (see sec.)	Label required if not exempt	Maximum quantity in 1 outside container by rail express
Tertiary butylisopropyl benzene hydroperoxide	Oxy. M	73.153 (b), 73.224	Yellow	1 quart.
Tetraethyl dithio pyrophosphate and compressed gas mixture	Pois. A	No exemption, 73.334	Poison Gas	Not accepted.
Tetraethyl dithio pyrophosphate, liquid	Pois. B	No exemption, 73.358	Poison	1 quart.
Tetraethyl dithio pyrophosphate mixture, dry	Pois. B	73.377	Poison	200 pounds.
Tetraethyl dithio pyrophosphate mixture, liquid	Pois. B	73.359	Poison	1 quart.
Tetraethyl lead, liquid	Pois. B	No exemption, 73.354	Poison	55 gallons.
Tetraethyl pyrophosphate and compressed gas mixture	Pois. A	No exemption, 73.334	Poison Gas	Not accepted.
Tetraethyl pyrophosphate, liquid	Pois. B	No exemption, 73.358	Poison	1 quart.
Tetraethyl pyrophosphate mixture, dry	Pois. B	73.377	Poison	200 pounds.
Tetraethyl pyrophosphate mixture, liquid	Pois. B	73.359	Poison	1 quart.
Tetrafluoroethylene, inhibited	F. G.	73.302, 73.308	Red Gas	300 pounds.
Tetranitromethane	Oxy. M.	No exemption, 73.203	Yellow	25 pounds.
Tetrazene (guanyl nitrosamino guanyl tetrazene). See Initiating explosive.				
Tetryl. See High explosives.				
Textile waste, wet	F. S.	No exemption, 73.211	Yellow	Not accepted.
Thallium salts, solid	Pois. B.	73.364, 73.365	Poison	200 pounds.
*Thallium sulfate, solid	Pois. B.	73.364, 73.365	do	Do.
*Thinning compounds, paint, varnish, lacquer, etc. *See* *Paint, enamel, lacquer, stain, shellac, varnish, etc.				
Thiocarbonyl-chloride. See Thiophosgene.				
Thionyl chloride	Cor. L.	No exemption, 73.247	White	1 gallon.
Thiophosgene (*Thiocarbonyl-chloride*)	Pois. B.	No exemption, 73.356	Poison	1 gallon.
Thiophosphoryl chloride	Cor. L.	No exemption, 73.271	White	1 quart.
Thorium metal, powdered	F. S.	73.226	Yellow	25 pounds.
Time fuzes	Expl. C.	No exemption, 73.105		150 pounds.
Tin tetrachloride, anhydrous	Cor. L.	73.244, 73.247	White	1 quart.
Titanium metal powder, dry	F. S.	No exemption, 73.208	Yellow	75 pounds.
Titanium metal powder, wet, with not less than 20 percent water	F. S.	No exemption, 73.208	Yellow	150 pounds.
Titanium tetrachloride	Cor. L.	73.244, 73.247	White	10 gallons.
Toluol (*toluene*)	F. L.	73.118, 73.119	Red	Do.
Torches. See Common fireworks.				
Torpedoes, cap. See Special fireworks.				
Torpedoes, empty	See § 73.55			
Torpedoes, explosives. See Explosive torpedoes.				
Torpedoes, railway or track. See Railway torpedoes.				
Toy propellant devices	Expl. C.	No exemption, 73.111		150 pounds.
Toy smoke devices	Expl. C.	No exemption, 73.111		150 pounds.
Toy torpedoes. See Special fireworks.				
Toy caps	Expl. C.	No exemption, 73.100(p), 73.109		150 pounds.
Tracers	Expl. C.	No exemption, 73.105		Do.
Tracer fuzes	Expl. C.	No exemption, 73.105		Do.
Tractors	See § 73.120			
Trailer or truck body with refrigerating or heating equipment on flat cars	See §§73.120 (c), 73.303			
Trichlorosilane	F. L.	No exemption, 73.136	Red	10 gallons.
Trick matches	Expl. C.	No exemption, 73.111		150 pounds.
Trifluorochloroethylene	F. G.	73.302, 73.308, 73.314	Red Gas	300 pounds.
Trimethylamine, anhydrous	F. G.	73.302, 73.308, 73.314, 73.315	Red Gas	Do.
Trimethylamine, aqueous solution	F. L.	73.118, 73.119	Red	10 gallons
Trimethylchlorosilane	F. L.	No exemption, 73.135	Red	10 gallons
Trinitrobenzene. See High explosives.				
Trinitrobenzene, wet (*not to exceed 16 ounces*)	F. S.	73.212		16 ounces.
Trinitrobenzoic acid, dry. See High explosives.				
Trinitrobenzoic acid, wet, not exceeding 16 ounces	See § 73.192			
Trinitrobenzoic acid, wet with not less than 10 percent water, *in excess of 16 ounces but not exceeding 25 pounds*	F. S.	No exemption, 73.193	Yellow	25 pounds.
Trinitrobenzoic acid, wet, with not less than 10 percent water, over 25 pounds. See High explosives.				
Trinitroresorcinol. See High explosives.				
Trinitrotoluene. See High explosives.				
Trinitrotoluene, wet (*not to exceed 16 ounces*)	F. S.	73.212		16 ounces.
*Turpentine substitutes	F. L.	73.118, 73.119	Red	10 gallons.
Uns-dimethylhydrazine	F. L.	No exemption, 73.145	Red	5 pints.
Urea nitrate wet with not less than 10 percent of water, over 25 pounds. See High explosives.				
Urea nitrate wet *with not less than 10 per cent of water, in excess of 16 ounces but not exceeding 25 pounds*	F. S.	No exemption, 73.193	Yellow	25 pounds.

* See § 72.4.

LIST OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES—*Concluded*

Article	Classed as	Exemptions and Packing (see sec.)	Label required if not exempt	Maximum quantity in 1 outside container by rail express
Urea nitrate, dry. *See* High explosives.				
Urea nitrate, wet *with not less than 10 percent of water, not exceeding 16 ounces*	See § 73.192			16 ounces.
Urea peroxide	Oxy. M.	73.153 (b), 73.227	Yellow	25 pounds.
*Varnish. *See* *Paint, enamel, lacquer, stain, shellac, varnish, etc.				
*Varnish driers. *See* *Paint driers, liquid.				
*Varnish remover or reducer. *See* *Compounds, lacquer, paint, or varnish removing, reducing, or thinning, liquid.				
*Varnish thinning compounds. *See* *Compounds, lacquer, paint, or varnish removing, reducing, or thinning, liquid.				
Very signal cartridges	Expl. C	No exemption, 73.100 (y), 73.108		200 pounds.
Vinyl acetate, inhibited	F. L.	73.118, 73.119	Red	10 gallons.
Vinyl chloride, inhibited	F. G.	73.302, 73.308, 73.314	Red Gas	300 pounds.
Vinylidene chloride, inhibited	F. L.	73.118, 73.119	Red	10 gallons.
Vinyl methyl ether, inhibited	F. G.	73.302, 73.308, 73.314	Red Gas	20 pounds.
Vinyl trichlorosilane	F. L.	No exemption, 73.135	Red	10 gallons.
War heads. *See* Explosive projectiles.				
Waste paper, wet	F. S.	No exemption, 73.186	Yellow	Not accepted.
Waste textile, wet	F. S.	No exemption, 73.211	do	Do.
Waste wool, wet	F. S.	No exemption, 73.213	Yellow	Not accepted.
*Water treatment compound, liquid	Cor. L.	73.244, 73.249	White	10 gallons.
Wet hair. *See* Hair wet.				
Wet nitrocellulose, colloided, granular or flake—20 percent alcohol or solvent	F. L.	73.118, 73.127	Red	25 pounds.
Wet nitrocellulose, colloided, granular or flake—20 percent water	F. S.	73.153, 73.184	Yellow	100 pounds.
Wet nitrocellulose—30 percent alcohol or solvent	F. L.	73.118, 73.127	Red	25 pounds.
Wet nitrocellulose—20 percent water	F. S.	73.153, 73.184	Yellow	100 pounds.
Wet nitroguanidine—20 percent water	F. S.	73.153, 73.184	do	Do.
Wet nitrostarch—20 percent water	F. S.	73.153, 73.184	do	Do.
Wet nitrostarch—30 percent alcohol or solvent	F. L.	73.118, 73.127	Red	25 pounds.
Wet paper stock. *See* Paper stock, wet.				
Wet rags. *See* Rags, wet.				
Wet textile waste. *See* Waste textile, wet.				
Wet waste paper. *See* Waste paper, wet.				
Wet waste wool. *See* Waste wool, wet.				
*Wood filler. *See* *Paint, enamel, lacquer, stain, shellac, varnish, etc.				
*Wood polish. *See* *Polishes, metal, stove, furniture and wood, liquid.				
*Wood stain, liquid. *See* *Paint, enamel, lacquer, stain, shellac, varnish, etc.				
Wool waste, wet. *See* Waste wool, wet.				
X-ray film (*nitrocellulose base*)	F. S.	No exemption, 73.177	Yellow	200 pounds.
X-ray film (*slow-burning*)	See § 73.181 (a) (1)			
X-ray film scrap (*nitrocellulose base*), samples of	F. S.	No exemption, 73.196	Yellow	25 pounds.
X-ray film scrap (*nitrocellulose base*), other than samples	F. S.	No exemption, 73.195	do	Not accepted.
X-ray film scrap (*slow-burning*)	See § 73.181 (a) (2)			
X-ray film, unexposed (*nitrocellulose base*)	F. S.	73.180	Yellow ##	250 pounds.
*Xylol (*xylene*)	F. L.	73.118, 73.119	Red	10 gallons.
Xylyl bromide	Pois. C.	No exemption, 73.382	Tear Gas	75 pounds.
Zinc ammonium nitrite	Oxy. M.	No exemption, 73.228	Yellow	100 pounds.
Zinc arsenate	Pois. B.	73.364, 73.365	Poison	200 pounds.
Zinc arsenite, solid	Pois. B.	73.364, 73.365	do	Do.
Zinc chlorate	Oxy. M.	73.153, 73.163	Yellow	100 pounds.
Zinc cyanide	See § 73.370			
Zinc ethyl	F .L.	No exemption, 73.134	Red	Not accepted.
Zinc nitrate. *See* Nitrates, n. o. s.				
Zinc permanganate	Oxy. M.	73.153, 73.154	Yellow	100 pounds.
Zinc peroxide	Oxy. M.	73.153, 73.154	do	100 pounds.
Zirconium metal powder or sponge, dry	F. S.	No exemption, 73.215	do	75 pounds.
Zirconium, metallic, solutions or mixtures thereof, liquid	F. L.	No exemption, 73.140	Red	5 pounds.
Zirconium metal powder, wet or sludge	F. S.	No exemption, 73.214	Yellow	150 pounds.
Zirconium picramate, wet *with 20 percent of water*	Oxy. M.	No exemption, 73.216	do	25 pounds.

* See § 72.4.

See § 72.4.

PART 73—REGULATIONS APPLYING TO SHIPPERS

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73.1 Purpose of the regulations in Parts 71-78.
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73.50 An explosive.
73.51 Forbidden explosives.
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73.53 Class A explosives; definitions.
73.54 Ammunition for cannon.
73.55 Ammunition, nonexplosive.
73.56 Ammunition, projectiles, grenades, bombs, mines, and torpedoes
73.57 Rocket ammunition.
73.58 Ammunition for small arms.
73.59 Chemical ammunition, explosive.
73.60 Black powder and low explosives.
73.61 High explosives.
73.62 High explosives, liquid.
73.63 High explosives with liquid explosive ingredient.
73.64 High explosives with no liquid explosive ingredient and propellant explosives, class A.
73.65 High explosives with no liquid explosive ingredient nor any chlorate.
73.66 Blasting caps and electric blasting caps.
73.67 Blasting caps with safety fuse.
73.68 Detonating primers.
73.69 Detonating fuzes, class A with or without radioactive components, detonating fuze parts containing an explosive, boosters, bursters, or supplementary charges.
73.70 Diazodinitrophenol or lead mononitroresorcinate.
73.71 Fulminate of mercury.
73.72 Guanyl nitrosamino guanylidene hydrazine.
73.73 Lead azide.
73.74 Lead styphnate.
73.75 Nitro mannite.
73.76 Nitrosoguanidine.
73.77 Pentaerythrite tetranitrate.
73.78 Tetrazene.
73.79 Jet thrust units (jato), class A, or igniters, jet thrust (jato), class A.
73.80 Charged oil well jet perforating guns.
73.86 Samples of explosives and explosive articles.
73.87 Explosives in mixed packing.
73.88 Class B explosives; definitions.
73.89 Ammunition for cannon with empty projectiles, inert-loaded projectiles, solid projectiles, or without projectiles or shell.
73.90 Rocket ammunition with empty projectiles, inert-loaded or solid projectiles, or without projectiles.
73.91 Special fireworks.
73.92 Jet thrust units (jato), class B, igniters, jet thrust (jato), class B, or starter cartridges, jet engine, class B.

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73.93 Propellant explosives for cannon, small arms, rockets, guided missiles, or other devices.
73.100 Class C explosives; definitions.
73.101 Small-arms ammunition.
73.102 Explosive cable cutters or explosive release devices.
73.103 Blasting caps not exceeding 1,000 caps.
73.104 Cordeau detonant fuse.
73.105 Percussion, tracer, combination, time fuzes and tracers.
73.106 Cartridge bags, empty, with black powder igniters; igniters, safety squibs, electric squibs, delay electric igniters, and fuse lighters or fuse igniters.
73.107 Primers, percussion caps, and empty grenades, primed.
73.108 Common fireworks, signal flares, hand signal devices, railway or highway fusees, smoke signals, smoke candles, smoke pots, and various signal cartridges.
73.109 Toy caps.
73.110 Charged oil well jet perforating guns, total explosive contents in guns not exceeding 15 pounds per motor vehicle.
73.111 Cigarette loads, explosive auto alarms, toy propellant devices, toy smoke devices, and trick matches.
73.112 Oil well cartridges.
73.113 Detonating fuzes, class C.
73.114 Fire extinguisher actuating cartridges.

Subpart C — Flammable Liquids; Definition and Preparation

73.115 Flammable liquids; definition.
73.116 Outage.
73.117 Closing and cushioning.
73.118 Exemptions for flammable liquids.
73.119 Flammable liquids not specifically provided for.
73.120 Automobiles, motorcycles, tractors, or other self-propelled vehicles.
73.121 Carbon bisulfide (disulfide).
73.122 Acrolein, inhibited.
73.123 Ethyl chloride.
73.124 Ethylene oxide.
73.125 Alcohol.
73.126 Nickel carbonyl.
73.127 Nitrocellulose or collodion cotton, fibrous, or nitrostarch, wet; colloided nitrocellulose, granular or flake, and lacquer base or lacquer chips, wet.
73.128 Paints and related materials.
73.129 Polishes, metal, stove, furniture and wood, liquid.
73.130 Refrigerating machines.
73.131 Road asphalt, or tar, liquid.
73.132 Container cement, linoleum cement, pyroxylin cement, rubber cement, tile cement, and wallboard cement and coating solution.
73.133 Spirits of nitroglycerin.
73.134 Aluminum triethyl, aluminum trimethyl, pyroforic fuel, or zinc ethyl.
73.135 Dimethyl dichlorosilane, ethyl trichlorosilane, methyl trichlorosilane, trimethyl chlorosilane, and vinyl trichlorosilane.
73.136 Methyl dichlorosilane and trichlorosilane.
73.137 Lithium aluminum hydride, ethereal.
73.138 Pentaborane.
73.139 Ethylene imine, inhibited.
73.140 Zirconium, metallic, solutions, or mixtures thereof, liquid.
73.141 Amyl mercaptan, butyl mercaptan, ethyl mercaptan, isopropyl mercaptan, propyl mercaptan, and aliphatic mercaptan mixtures.
73.143 Methylchloromethyl ether, anhydrous.
73.144 Inks.
73.145 Methylhydrazine and uns-dimethylhydrazine.
73.146 Heaters for refrigerator cars, liquid fuel type.

Subpart D — Flammable Solids and Oxidizing Materials; Definition and Preparation

73.147 Methyl vinyl ketone, inhibited.
73.150 Flammable solid; definition.
73.151 Oxidizing material; definition.
73.152 Packing.
73.153 Exemptions for flammable solids and oxidizing materials.

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73.154 Flammable solids and oxidizing materials not specifically provided for.
73.155 Bags, nitrate of soda, empty and unwashed.
73.156 Barium peroxide and calcium peroxide.
73.157 Benzoyl peroxide, chlorobenzoyl peroxide (para), lauroyl peroxide, or succinic acid peroxide, wet.
73.158 Benzoyl peroxide, dry, lauroyl peroxide, dry, chlorobenzoyl peroxide (para), dry, or succinic acid peroxide, dry.
73.159 Burnt cotton.
73.160 Calcium chlorite and sodium chlorite.
73.161 Calcium phosphide.
73.162 Charcoal.
73.163 Chlorate of soda, chlorate of potash, and other chlorates.
73.164 Chromic acid.
73.165 Coal, ground bituminous, sea coal, coal facings.
73.166 Cobalt resinate, precipitated, calcium resinate and calcium resinate fused.
73.167 Cotton waste, oily.
73.168 Lithium amide, powdered.
73.169 Fiber, burnt.
73.170 Fibers or fabrics impregnated, saturated or coated.
73.171 Fish scrap or fish meal.
73.172 Hair, wet.
73.173 Aluminum dross or magnesium dross.
73.174 Iron sponge, spent oxide, spent iron mass, or spent iron sponge.
73.175 Lacquer base, or lacquer chips, dry.
73.176 Matches.
73.177 Motion-picture film and X-ray film.
73.178 Motion-picture film, old and worn out (not scrap).
73.179 Motion-picture film, toy.
73.180 Motion-picture film, and X-ray film, unexposed.
73.181 Motion-picture film; exemptions.
73.182 Nitrates.
73.183 Potassium nitrate mixed, (fused) with sodium nitrite.
73.184 Nitrocellulose or collodion cotton, wet, nitrocellulose, colloided, granular, or flake, wet, or nitrostarch, wet, or nitroguanidine, wet.
73.185 Paper stock, wet.
73.186 Paper waste, wet.
73.187 Peroxide of sodium.
73.188 Phosphoric anhydride.
73.189 Phosphorus, amorphous, red.
73.190 Phosphorus, white or yellow.
73.191 Phosphorus pentachloride.
73.192 Picrate of ammonia (ammonium picrate), picric acid, trinitrobenzoic acid, and urea nitrate, wet.
73.193 Picric acid, trinitrobenzoic acid, or urea nitrate, wet.
73.194 Potassium permanganate.
73.195 Pyroxylin plastic scrap, photographic film scrap, X-ray film scrap, motion-picture film scrap, or pieces of exposed or unexposed film.
73.196 Pyroxylin plastic scrap, photographic film scrap, X-ray film scrap, motion-picture film scrap, or pieces of exposed or unexposed film, shipments by rail express.
73.197 Pyroxylin plastics, in sheets, rolls, rods, or tubes.
73.198 Sodium hydride.
73.199 Rags, oily.
73,200 Rags, wet.
73.201 Rubber scrap, rubber buffings, reclaimed rubber or regenerated rubber.
73.202 Sodium and potassium, metallic liquid alloy.
73.203 Tetranitromethane.
73.204 Sodium hydrosulfite.
73.205 Sodium picramate, wet.
73.206 Sodium or potassium, metallic, sodium amide, sodium potassium alloys, lithium metal, lithium silicon, lithium hydride and lithium aluminum hydride.
73.207 Sulfide of sodium or sulfide of potassium, fused or concentrated, when ground.
73.208 Titanium metal powder, wet or dry.
73.209 Tankages, garbage, and tankage fertilizers.
73.210 Tankages, rough ammoniate.
73.211 Textile waste, wet.
73.212 Trinitrobenzene and trinitrotoluene, wet.
73.213 Wool waste, wet.
73.214 Zirconium metal powder or hafnium metal powder, wet or sludge.
73.215 Zirconium or hafnium metal powder or sponge, dry.
73.216 Zirconium picramate, wet.
73.217 Calcium hypochlorite compounds, dry, and lithium hypochlorite compounds, dry.
73.218 Isopropyl percarbonate, unstabilized.

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73.219 Potassium perchlorate.
73.220 Magnesium scrap (borings, clippings, shavings, sheets, or turnings).
73.221 Liquid peroxides other than acetyl peroxide solution, acetyl benzoyl peroxide solution, cumene hydroperoxide, dicumyl peroxide, hydrogen peroxide, peracetic acid, and tertiary butylisopropyl benzene hydroperoxide.
73.222 Acetyl peroxide and acetyl benzoyl peroxide solution.
73.223 Peracetic acid.
73.224 Cumene hydroperoxide, dicumyl peroxide, and tertiary butylisopropyl benzene hydroperoxide.
73.225 Phosphorus sesquisulfide.
73.226 Thorium metal, powdered.
73.227 Urea peroxide.
73.228 Zinc ammonium nitrite.
73.229 Chlorate and borate mixtures or chlorate and magnesium chloride mixtures.
73.230 Sodium, metallic, dispersion in organic solvent.
73.231 Calcium, metallic, crystalline.
73.232 Tank cars containing residual phosphorus.
73.233 Nickel catalyst, finely divided, activated, or spent.
73.234 Sodium nitrite.
73.235 Ammonium bichromate

Subpart E — Acids and Other Corrosive Liquids; Definition and Preparation

73.240 Acids and other corrosive liquids; definition.
73.241 Outage.
73.242 Bottles containing acid or other corrosive liquids.
73.243 Closing and cushioning.
73.244 Exemptions for acids and other corrosive liquids.
73.245 Acids or other corrosive liquids not specifically provided for.
73.246 Antimony pentafluoride.
73.247 Acetyl chloride, antimony pentachloride, benzoyl chloride, benzyl chloride, chromyl chloride, pyro sulfuryl chloride, silicon chloride, sulfur chloride, (mono and di), sulfuryl chloride, thionyl chloride, tin tetrachloride (anhydrous), and titanium tetrachloride.
73.248 Acid sludge, sludge acid, spent sulfuric acid, or spent mixed acid.
73.249 Alkaline corrosive liquids, n. o. s., alkalline caustic liquids, n. o. s., and alkaline battery fluids, and sodium aluminate, liquid.
73.250 Automobiles or other self-propelled vehicles, engines or other mechanical apparatus.
73.251 Boron trichloride.
73.252 Bromine.
73.253 Chloracetyl chloride.
73.254 Chlorosulfonic acid and mixtures of chlorosulfonic acid-sulfur trioxide.
73.255 Dimethyl sulfate.
73.256 Compounds, cleaning, liquid.
73.257 Electrolyte (acid) or corrosive battery fluid.
73.258 Electrolyte, acid, or alkaline corrosive battery fluid, packed with storage batteries.
73.259 Electrolyte, acid, or alkaline corrosive battery fluid, packed with battery charger or radio current supply device, or electronic equipment.
73.260 Electric storage batteries, wet.
73.261 Fire-extinguisher charges.
73.262 Hydrobromic acid.
73.263 Hydrochloric (muriatic) acid, hydrochloric (muriatic) acid mixtures, hydrochloric (muriatic) acid solution, inhibited, sodium chlorite solution, and cleaning compounds, liquid, containing hydrochloric (muriatic) acid.
73.264 Hydrofluoric acid.
73.265 Hydrofluosilicic acid.
73.266 Hydrogen peroxide solution in water.
73.267 Mixed acid (nitric and sulfuric acid) (nitrating acid).
73.268 Nitric acid.
73.269 Perchloric acid.
73.270 Phosphorus tribromide.
73.271 Phosphorus oxychloride, phosphorus trichloride, and thiophosphoryl chloride.
73.272 Sulfuric acid.
73.273 Sulfur trioxide, stabilized.
73.274 Fluosulfonic acid.
73.275 Difluorophosphoric acid, anhydrous, monofluorophosphoric acid, anhydrous, hexafluorophosphoric acid, and mixtures thereof.
73.276 Anhydrous hydrazine and hydrazine solution.
73.277 Hypochlorite solutions.
73.278 Nitrohydrochloric acid.
73.279 Anisoyl chloride.

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73.280 Allyl trichlorosilane, amyl trichlorosilane, butyl trichlorosilane, cyclohexenyl trichlorosilane, cyclohexyl tricholorsilane, diethyl dichlorosilane, diphenyl dichlorosilane, dodecyl trichlorosilane, ethyl phenyl dichlorosilane, hexadecyl trichlorosilane, hexyl trichlorosilane, nonyl trichlorosilane, octadecyl trichlorosilane, octyl trichlorosilane, phenyl trichlorosilane, and propyl trichlorosilane.
73.281 Alpha-Bromotoluene (benzyl bromide).
73.282 Isopropyl percarbonate, stabilized.
73.283 Bromine trifluoride.
73.284 Bromine pentafluoride.
73.285 Chlorine trifluoride.
73.286 Chemical kits.
73.287 Chromic acid solution.
73.288 Allyl chloroformate, benzyl chloroformate, ethyl chloroformate, and methyl chloroformate.
73.289 Formic acid and formic acid solutions.
73.290 Mixtures of hydrofluoric and sulphuric acid.
73.291 Flame retardant compound, liquid.
73.292 Hexamethylene diamine solution.
73.293 Iodine monochloride.
73.294 Monochloroacetic acid, liquid.

Subpart F — Compressed Gases; Definition and Preparation

73.300 Compressed gases; definition.
73.301 General requirements.
73.302 Exemptions for compressed gases.
73.303 Truck bodies or trailers on flat cars, automobiles, motorcycles, tractors, or other self-propelled vehicles.
73.304 Filling limits.
73.305 Compressed gas mixtures.
73.306 Liquefied gases, except acetylene in solution.
73.307 Nonliquefied gases, except gas in solution or poisonous gas.
73.308 Compressed gases in cylinders.
73.309 Acetylene gas.
73.310 Fire extinguishers and component parts thereof.
73.311 Fluorine.
73.312 Liquefied petroleum gas.
73.313 Refrigerating machines and hydraulic accumulators.
73.314 Compressed gases in tank cars.
73.315 Compressed gases in cargo tanks and portable tank containers.

Subpart G—Poisonous Articles; Definition and Preparation

73.325 Classes of poisonous articles.
73.326 Extremely dangerous poisons—class A—Poison Gas label; definition.
73.327 Packing.
73.328 Poisonous gases and liquids not specifically provided for.
73.329 Bromacetone; chlorpicrin and methyl chloride mixtures.
73.330 Chemical ammunition.
73.331 Gas identification sets.
73.332 Hydrocyanic acid, liquid (prussic acid) and hydrocyanic acid liquefied.
73.333 Phosgene or diphosgene.
73.334 Hexaethyl tetraphosphate, parathion, tetraethyl dithio pyrophosphate, and tetraethyl pyrophosphate mixtures with compressed gas.
73.335 Police grenades.
73.336 Nitrogen dioxide, liquid (nitrogen peroxide, tetroxide).
73.337 Nitric oxide.
73.343 Less dangerous poisons—class B—liquid or solid —Poison label; definition.
73.344 Packing for class B poisons, liquid.
73.345 Exemptions for poisonous liquids, class B.
73.346 Poisonous liquids not specifically provided for.
73.347 Aniline oil.
73.348 Arsenic acid.
73.349 Carbolic acid (phenol) liquid.
73.350 Chemical ammunition.
73.351 Hydrocyanic acid solution.
73.352 Liquid sodium or potassium cyanide.
73.353 Methyl bromide or mixtures of methyl bromide and ethylene dibromide, liquid.
73.354 Motor fuel antiknock compound or tetraethyl lead.
73.355 Phenyldichlorarsine.

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73.356 Thiophosgene.
73.357 Chlorpicrin and chlorpicrin mixtures containing no compressed gas or poisonous liquid, class A.
73.358 Hexyl tetraphosphate, methyl parathion, parathion, tetraethyl dithio pyrophosphate, and tetraethyl pyrophosphate, liquid.
73.359 Hexaethyl tetraphosphate mixtures, methyl parathion mixtures, parathion mixtures, tetraethyl dithio pyrophosphate mixtures, and tetraethyl pyrophosphate mixtures, liquid.
73.360 Perchloro-methyl-mercaptan.
73.361 Aldrin mixtures, liquid, with more than 60 percent aldrin.
73.362 Chloro-o-toluidine hydrochloride.
73.363 Packing for class B poisons, solid.
73.364 Exemptions for poisonous solids, class B.
73.365 Poisonous solids not specifically provided for.
73.366 Arsenic (arsenic trioxide) or arsenic acid (solid).
73.367 Arsenical compounds, n. o. s., arsenate of lead, calcium arsenate, Paris green, and arsenical mixtures.
73.368 Arsenical dust, arsenical flue dust, and other poisonous noncombustible by-product dusts.
73.369 Carbolic acid (phenol), not liquid.
73.370 Cyanides, or cyanide mixtures, except cyanide of calcium and mixtures thereof.
73.371 Dinitrobenzol.
73.372 Mercury bichloride.
73.373 Paranitraniline.
73.374 Nitrochlorbenzene, meta or para.
73.375 Sodium azide.
73.376 Aldrin mixtures, dry, with more than 65 percent aldrin.
73.377 Hexaethyl tetraphosphate mixtures, methyl parathion mixtures, parathion mixtures, tetraethyl dithio pyrophosphate mixtures, and tetraethyl pyrophosphate mixtures, dry.
73.378 Beryllium metal powder.
73.381 Tear gas or irritating substances—class C—Tear Gas label; definition.
73.382 Tear gas or irritating substances, class C, not specifically provided for.
73.383 Chemical ammunition.
73.384 Monochloracetone, stabilized.
73.385 Tear gas grenades, tear gas candles, or similar devices.
73.391 Radioactive materials—class D poison; definition.
73.392 Exemptions for radioactive materials.
73.393 Packing and shielding.
73.394 Radioactive materials labels.
73.395 Cleaning cars and vehicles.
73.396 Radioactive materials handling.

Subpart H—Marking and Labeling Explosives and Other Dangerous Articles

73.400 Explosives.
73.401 Dangerous articles.
73.402 Labeling dangerous articles.
73.404 Labels.
73.405 Flammable liquids label.
73.406 Flammable solids and oxidizing materials label.
73.407 Acids, corrosive liquids, and alkaline caustic liquids labels.
73.408 Compressed gas labels.
73.409 Poisonous articles and tear gas labels.
73.410 Special fireworks label.
73.411 Explosives samples for laboratory examination label.
73.412 Propellant explosives label for express shipment.
73.413 Empty container label
73.414 Radioactive materials labels.

Subpart I—Shipping Instructions

73.425 "Order-notify," "C.O.D." and "Stop-off" shipments.
73.426 Cars containing lading which has been fumigated or treated with flammable liquids, flammable gases, poisonous liquids or solids, or poisonous gases.
73.427 Shipping order and bill of lading description.
73.428 Label or placard notation.
73.429 Receipts; rail express shipments.
73.430 Certificate.
73.431 Switching ticket.
73.432 Tank car shipments.

AUTHORITY: §§73.1 to 73.432 issued under sec. 204, 49 Stat. 546, as amended, sec. 835, 62 Stat. 739;49 U.S.C. 304, 18 U.S.C., Sup., 835.

The regulations in Parts 71-78 are applicable to every common, contract, and private carrier of property subject to the regulatory provisions of section 835 Public Law 772, 80th Congress (62 Stat. 738), and/or Part II of the Interstate Commerce Act.

Private carriers by public highway subject to Parts 71-78 are prohibited from transporting any explosive or other dangerous article unless the article is properly described by name in papers required by Parts 71-78, to accompany every shipment of such article; and that every such article must be packed and marked and in proper condition for transportation according to the regulations in Parts 71-78.

NOTE 1: Because of the present emergency and until further order of the Commission, the following regulations shall apply to transportation of flammable liquids by private carriers of property in interstate or foreign commerce:

All regulations heretofore applying to common or contract carriers by motor vehicle shall apply to such private carriers, except:

Cargo tanks of tank motor vehicles constructed previous to June 15, 1943, may be continued in service if maintained in safe operating condition and sufficiently frequent inspections are maintained to determine compliance with all requirements as specified in this note.

Any defect or deficiency, due to accident or otherwise, that is likely to cause serious hazard must be corrected before any such tank is continued in or returned to service; see however, §77.856.

Requirements applying to tests of tanks, and provisions for markers thereon except that indicating the flammable nature of the cargo, are waived.

Outages for shipment shall be those provided for by this part, except that filling of tanks to outage markers already incorporated in tanks, having due regard for safety in the transportation of the flammable liquids, need not be changed.

Section 77.815, labels, and §77.819, certification of packages, of these regulations, need not be complied with by such private carriers, except as to packages transferred from one carrier to another.

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§ 73.1 **Purpose of the regulations in Parts 71-78.** (a) To promote the uniform enforcement of law and to minimize the dangers to life and property incident to the transportation of explosives and other dangerous articles by common carriers engaged in interstate or foreign commerce, the regulations in Parts 71-78 are prescribed to define these articles for transportation purposes, to state the precautions that must be observed by the shipper in preparing them for shipment by rail freight, rail express, rail baggage, highway, or by carrier by water. It is the duty of each such shipper to make the prescribed regulations effective and to thoroughly instruct employees in relation thereto.

(b) Explosives and other dangerous articles may be offered to carriers for transportation provided the articles are in proper condition for transportation, are as defined, and are packed, marked, labeled, described, certified, and otherwise as provided for in Parts 71-78 for acceptable articles for transportation by rail freight, rail express, rail baggage, highway, or water. Articles must be loaded and stayed according to regulations in Parts 71-78 applying to carriers by rail. Methods of manufacture, packing, and storage, insofar as they affect safety in transportation, must be open to inspection by a duly authorized representative of the initial carrier or of the Bureau of Explosives. Shipments that do not comply with the regulations in Parts 71-78 must not be offered for transportation.

§ 73.2 **Classification; dangerous articles.** (a) Dangerous articles other than explosives having more than one hazardous characteristic, as defined by the regulations in Parts 71-78, must be classified according to the greatest hazard present, except those articles which are also poisons, class A, or class D, which must be classified according to both dangerous characteristics as defined herein.

§ 73.3 **Motor carrier regulations.** (a) The packing required for shipments to be offered for transportation by motor carrier is as specified in this part.

§ 73.4 **Water carrier regulations.** (a) The packing required for shipments to be offered to common carriers by water is as specified in this part.

§ 73.5 **Shipments by rail express.** (a) The packing required for shipments to be forwarded by rail express will be, unless otherwise indicated, as prescribed for shipments by rail freight, provided the quantity limitations in one outside container, as shown in § 72.5, are observed.

§ 73.6 **Shipments as baggage by rail.** (a) For shipments of explosives and other dangerous articles acceptable as baggage by rail carriers see Part 76, Regulations Applying to Rail Carriers in Baggage Service.

§ 73.7 **United States Government shipments.** (a) Shipments of explosives or other dangerous articles offered by or consigned to the Departments of the Army, Navy, and Air Force of the United States Government, must be packed, including limitations of weight, in accordance with the regulations in this part or in containers of equal or greater strength and efficiency as required by their regulations.

(b) Shipments of radioactive materials, made by the Atomic Energy Commission, or under its direction or supervision, which are escorted by personnel specially designated by the Atomic Energy Commission, are exempt from the regulations in Parts 71-78.

§ 73.8 **Canadian shipments.** (a) Explosives and other dangerous articles, as defined in Parts 71-78 which are packed, marked, labeled, and loaded, in conformity with the regulations of the Board of Transport Commissioners for Canada, may be transported from point of entry in the United States to their destination in the United States or through the United States en route to a point in Canada.

NOTE 1: Because of the present emergency and until further order of the Commission, compressed gas cylinders 40 inches in length and 8 inches in diameter, charged with not more than 40 pounds of carbon dioxide or when charged with nitrogen not in excess of 2,000 pounds per square inch, and shipped by or to the Canadian Department of National Defense in accordance with Board of Transport Commissioners for Canada Order No. 76253 dated March 10, 1951, may be shipped to destinations in the United States or through the United States to points in Canada.

(b) Specification containers made and maintained in full compliance with corresponding specifications prescribed by the Board of Transport Commissioners for Canada in its Regulations for the Transportation of Explosives and Other Dangerous Articles by Freight, and Specifications for Shipping Containers, and marked in accordance therewith, BTC, CRC, etc., may be used for shipment of explosives and other dangerous articles offered for transportation by carriers by rail freight, rail express, highway, or water.

§ 73.9 **Import and export shipments.** (a) Import shipments of explosives and other dangerous articles offered in the United States in original packages for transportation by carriers by rail freight, rail express, motor vehicle, or water must comply with all requirements of the regulations in Parts 71-78. Except for shipments from Canada conforming with § 73 8, the importer must furnish with the order to the foreign shipper, and also to the forwarding agent at the port of entry, full and complete information as to the packing, marking, labeling, and other requirements, as prescribed in Parts 71-78, and the forwarding agent must file with the initial carrier in the United States a properly certified shipping order or other shipping papers as prescribed in this part. Except for the requirements of §§77.817 and 77.823, the provisions of Parts 71-78 do not opply to such transportation by motor vehicle or water as may be necessary to effect transfer of import shipments from place of discharge to other places within the same port area or delivery to a water carrier within the same port area (including continguous harbors). Further transportation of such import shipments by connecting water carrier shall be subject to the regulations prescribed by the Commandant of the Coast Guard.

(b) Shipments of explosives and other dangerous articles offered for transportation by common carrier by water from the United States, its insular possessions, or dependencies, destined to such insular possessions or territory, dependencies, or to a foreign country, must be packed, marked, labeled and described in accordance with the rules and regulations in force at destination ports or as prescribed in Parts 71-78.

(c) Outside shipping containers for export shipments offered for transportation by carriers subject to Parts 71-78 may have specification markings prescribed for containers plainly and legibly shown on labels or tags securely fastened thereto in lieu of marking requirements as prescribed for containers by Part 78.

§ 73.10 **Inefficient containers.** (a) The results of experience gained by examination of broken or leaking containers must be recorded by the Bureau of Explosives to the end that further use of any particular kind of container shown by experience to be inefficient, may be prohibited by the Commission.

§ 73.11 **Violations and accidents to be reported.** (a) Consignees must report promptly to the Bureau of Explosives all instances of improper staying and broken, leaking, or defective containers of explosives or other dangerous articles in shipments received by them.

(b) The Bureau of Explosives, upon receipt of reports from consignees, should promptly report to the shipper full particulars covering all such cases.

SUBPART A—PREPARATION OF ARTICLES FOR TRANSPORTATION BY CARRIERS BY RAIL FREIGHT, EXPRESS, HIGHWAY, OR WATER

§ 73.21 **Prohibited packing.** (a) The offering of packages of dangerous articles in outside packages containing in the same compartment interior packages the mixture of contents of which would be liable to cause a dangerous evolution of heat or gas or produce corrosive materials is prohibited for transportation by common carriers by rail freight, rail express, highway, or water, except as specified in §§ 73.152(a), 73.242(a), (b), and 73.301 (a).

(b) The offering for transportation of any package or container of any liquid, solid, or gaseous material which under conditions incident to transportation may polymerize (combine or react with itself) or decompose so as to cause dangerous evolution of heat or gas is prohibited. Such materials may be offered for transportation when properly stabilized or inhibited. Refrigeration may be used as a means of stabilization only when approved by the Bureau of Explosives.

(c) The offering for transportation of any package or container of any material which will cause a dangerous evolution of heat or gas under conditions normally incident to transportation is forbidden.

§ 73.22 **Specification containers prescribed.** (a) Shipping containers, unless otherwise provided in this part (see § 73.9 (c)) used hereafter in shipping explosives or other dangerous articles, must have been made, assembled with all parts or fittings in their proper place, and marked in compliance with specifications prescribed in Part 78 or with specifications of the Commission in effect at date of manufacture of container.

(1) Because of the present emergency and until further order of the Commission, containers approved for emergency or experimental shipments may be authorized in the discretion of, and upon special permit to be issued by the Director of Acting Director, Bureau of Safety and Service, Washington, D. C.

(b) Containers that do not comply with the specifications must not be marked to indicate such compliance.

(c) Containers not specified in this part, made before the effective date of the regulations in Parts 71-78 and authorized for use under the regulations effective October 1, 1930, which may be continued in use, are as follows:

When these regulations call for specification numbers—	These specification containers may also be used—	
1A	1	Boxed carboy, glass or earthenware.
1B	1	Boxed carboy, lead.
1C	1	Carboy in keg, glass or earthenware.
3A	3, 25, 26	Cylinder.
3AA	3, 25, 26	Do.
3B	26	Do.
3C	7	Do.
3D	33	Do.
3E	3	Do.
4A	26	Do.
4B	26, 38	Do.
4BA	26, 38	Do.
4C	7	Do.
6B	20A	Metal drum.

(d) Metal barrels and drums manufactured previous to March 31, 1912, of not to exceed 55 gallons nominal capacity, and made of metal not lighter than 16 gauge, may be continued in service after each metal barrel or drum has been subjected to and has passed hydrostatic interior pressure test of not less than 30 pounds per square inch for at least five minutes, without bulging either head beyond the chime and without leakage of liquid contents, and after each such metal barrel or drum passing the test has been plainly and permanently marked:

Mfd. before 3-31-12
ICC-5
Tested ....
(Date)

and with the date of the retest, by stamping into the metal or by means of a plate securely attached to the container.

(e) Spec. 5G metal drums manufactured prior to May 12, 1954, may be continued in service until further order of the Commission.

(f) Where the regulations require spec. 37A or 37B metal drums, spec. 37D, 37E, 37F, 37G, and 37H metal drums manufactured prior to August 30, 1955, may be continued in use for commodities and gross weights for which they were previously authorized until further order of the Commission.

§ 73.23 **Closures for containers.** (a) Containers must be closed for shipment as prescribed in the specifications for the container unless otherwise authorized for the particular article being shipped. Gasketed closures must be fitted with gaskets of efficient material which will not be deteriorated by the contents of the container.

§ 73.24 **Design of containers.** (a) In addition to standing the tests prescribed, the design and construction of inside and outside containers must be such as to prevent the occurrence in individual packages of defects that permit leakage of their contents under ordinary conditions incident to transportation.

(b) Articles for which detailed specifications for packing are not given in this part must be securely packed in containers strong enough to stand, without rupture or leakage of contents, all shocks ordinarily incident to handling during transit.

§ 73.25 **Specification containers in outside containers.** (a) Outside specification shipping containers containing no acids or corrosive liquids may be shipped when tightly packed in strong outside fiberboard boxes or drums, wooden boxes, barrels or crates, metal barrels or drums, or other enclosures. The outside shipping container must be marked with the prescribed name of contents and labeled as required. Packages required by the regulations in this part to be marked **"This Side Up"** or **"This End Up"** must be packed in the outside package with their filling holes up, and the outside package must be marked **"THIS SIDE UP"** or **"THIS END UP."** The outside container must also be marked **"INSIDE PACKAGES COMPLY WITH PRESCRIBED SPECIFICATIONS"** unless the the specification markings on the inside packages are visible through openings in the outside package.

(b) Outside specification shipping containers containing acids or other corrosive liquids, except nitric acid, perchloric acid, or hydrogen peroxide solution containing over 52 percent hydrogen peroxide by weight, may be shipped when tightly packed in strong outside fiberboard or wooden boxes, or in wooden crates, provided such outside container shall not contain any other article except under the following conditions:

(1) As provided in §§ 73.242, 73.257, 73.258, 73.259, 73.260, 73.261, and 73.286.

(2) Electrolyte acid or alkaline corrosive battery fluid in packages prescribed in §§ 73.257 and 73.258 may be included in outside shipping containers with dry charged storage batteries when packed to prevent movement within the outside containers.

(3) The outside container shall be marked with the prescribed names of contents and labeled as required and shall be marked "THIS SIDE UP" or "THIS END UP." The outside container must also be marked "INSIDE PACKAGES COMPLY WITH PRESCRIBED SPECIFICATIONS" unless the specification markings on the inside packages are visible through openings in the outside package.

§ 73.26 **Quantity limitations.** (a) When quantity limitations are specified in Parts 71-78 by United States liquid measure or by avoirdupois weight it is authorized that quantities measured by the metric system may be substituted, up to not exceeding 1 gallon for liquids and 10 pounds for solids, on the basis of 1 liter per quart specified and 500 grams per pound specified.

(b) When quantity limitations do not appear in the packing requirements, the permitted gross weight or capacity authorized for a container to be offered for transportation by carrier by rail freight, rail express, highway, or water is shown in the container specification. (See also § 73.27 of this part.)

§ 73.27 **Rail express limitations.** (a) Dangerous articles other than explosives, except such as are not accepted for transportation, and except where special packing is prescribed in this part for rail express shipments, must, when offered for shipment by rail express, be packed, marked and labeled in compliance with this part.

(b) The maximum quantity of any explosive or other dangerous article that may be offered for transportation by rail express in one outside container must not exceed that as shown in § 72.5.

(c) When several dangerous articles are placed in one outside package without violating the regulations, the combined quantity of any one group must not exceed the lowest limit prescribed for any one of the articles of that group that is included.

§ 73.28 **Reused containers.** (a) Containers used more than once (refilled and reshipped after having been previously emptied) must be in such condition, including closing devices and cushioning materials, that they will protect their contents during transit as efficiently as new containers. Repairs must be made in an efficient manner and parts that are weak, broken, or otherwise deteriorated must be replaced (see paragraph 28 (e), (f), (g), and (h) of this section, for containers that cannot be reused).

(1) Retest of carboy packages must have been made by or for shippers, or their authorized agents, as required by applicable provisions of the specifications in Part 78 before carboys which are to be offered for transportation are filled.

NOTE 1: Tests not required by shipper who fills and ships or who reships filled carboys for one shipment only carboy packages which have been properly tested by another shipper or a duly authorized agency.

(b) Markings applied as prescribed by the specifications must be maintained in a legible condition.

(c) If, on account of painting or any other reason, the markings as prescribed for any container cannot be kept plain and legible, a metal plate, brazed or soldered, or otherwise securely fastened to the container, with a reproduction of the prescribed markings plainly stamped thereon, will be permitted.

(d) Containers previously used for the shipment of any explosive or other dangerous article must have the old markings, including name of contents, addresses, and labels, if any, thoroughly removed or obliterated before being used for the shipment of other articles.

(e) Boxes previously used for high explosives containing a liquid explosive ingredient not contained in an inside metal container must not be again used for shipments of any character.

(1) Boxes that have been contaminated by liquid explosive compositions must not again be used for shipments of any character.

(f) Kegs previously used for any chlorate must not be again used for shipments of any character.

(g) Metal kegs previously used for black powder not contained in an interior package must not be again used for shipment of any explosive.

NOTE 1: Because of the present emergency and until further order of the Commission, metal kegs, previously used for the shipment of black powder not contained in an interior package, may be used provided the kegs are in good physical condition and are not liable to permit escape of contents during transportation. Empty kegs previously used for shipments of black powder must be entirely free of black powder on the inside and outside before being offered for transportation.

(h) Single-trip containers made under specifications prescribed in Part 78 from which contents have once been removed following use for shipment of any article, must not be again used as shipping containers for explosives, flammable liquids, flammable solids, oxidizing materials, corrosive liquids, or poisons, class B or C, as defined in this part: **Provided,** That during the present emergency and until further order of the Commission, single-trip containers may be reused if retested and approved for service by the Bureau of Explosives. Applications for permission for reuse should be made to the Bureau of Explosives, 30 Vesey Street, New York 7, N. Y.

§ 73.29 **Empty containers.** (a) Empty cylinders, barrels, kegs, drums, or other containers except carboys (see paragraph (c) of this section) previously used for the shipment of any explosive or other dangerous article, as defined in this part, if authorized for reuse must have all openings including removable heads, filling and vent holes, tightly closed before being offered for transportation. Small quantities of the material with which containers were loaded may remain in "empty" containers and when the vapors remaining therein are unstable, it is permissible to add sufficient inert gas to render the vapors stable.

(b) They may be loaded in open or stock cars when desired. Cars should not be placarded but lighted open-flame lanterns or other open-flame lights should be kept away.

(c) Carboys previously used for the shipment of corrosive liquids when offered to carriers for transportation as "empty" carboys, must have been thoroughly (completely) drained. Whenever practicable they should not be loaded with valuable or perishable freight.

(d) Empty bottles other than carboys previously used for the shipment of acids or other corrosive liquids must be securely stoppered.

(e) All containers and accessories which have been used for shipments of radioactive materials when shipped as empty must be sufficiently free of radioactive contamination so as to conform to the conditions of paragraph (a) (1), (2), and (3) of §73.392 of this part.

(f) Containers shipped as "empty" must have the old labels prescribed by this part removed, obliterated, destroyed, or completely covered by a square white label as described in § 73.413 of this part, measuring not less than six inches on each side, and bearing thereon the word "EMPTY" in letters not less than one-inch high. This does not apply to carload or truckload shipments to be unloaded by consignee.

§ 73.30 **Loading and placarding of cars by shippers and unloading of cars by consignees.** (a) When shipments of explosives or other dangerous articles are loaded into cars by shippers, or unloaded from cars by the consignee or his duly authorized agent, the applicable provisions of Part 74 must be complied with. See § 74.538 for loading and storage chart.

§ 73.31 Qualification, maintenance, and use of tank cars. (a) Tanks mounted on or forming part of a car and built in compliance with the American Railway Association's specifications for tank cars prior to July 1, 1927; or built in compliance with the Commission's specifications for tanks of tank cars in force prior to the effective date of Parts 71-78, including tanks already constructed or under construction on the effective date hereof in compliance with trial specifications for fusion-welded tanks of tank cars are authorized for service, until further order of the Commission, as follows:

Where these regulations call for specifications numbers	These specification containers may also be used subject to the provisions of the following notes:
103[4, 5, 9, 11] and 103-W[4, 5, 9, 11]	ARA-II[1, 4, 5, 11], III[4, 5, 9, 11] and IV[5, 9]
103A[4, 11] and 103A-W[4, 11]	ARA-II[2, 4, 11] and III[2, 4, 11]
103B[4, 11] and 103B-W[4, 11]	ARA-II[4, 11] and III[4, 11] rubber lined
103C-W	103C[8]
103D-W, 103E-W, 103A-N-W	(See Note 10)
104[4, 9, 11] and 104-W[4, 9, 11]	ARA-IV[4, 9, 11]
105A100 and 105A100-W	104A[7] and 104A-W[7]
105A100-AL-W	104A-AL-W[7]
105A300-W	ARA-V[3], ICC-105[3] and 105A300[3]
105A400-W	105A400
105A500-W	105A500
105A600-W	105A600
106A500 and 106A500-X	ICC-27 tanks mounted on a car and classified as multi-unit tank prior to October 1, 1930[6]
106A800 and 106A800-X	None
106A800NCI	None
107A****	None

[1] Tank must be tested to a pressure of 60 pounds per square inch and safety valves must be set to open at a pressure of 25 pounds per square inch. Tank cars having head block anchorage must not be used for the transportation of flammable liquids.

[2] Tanks and their appurtenances must have been originally designed or subsequently reconstructed for the transportation of acids.

[3] Safety valves on these cars must be set to open at pressure not exceeding 225 pounds per square inch.

[4] Tank cars equipped with safety vents must have the vent closure so chained or otherwise fastened as to prevent misplacement.

[5] These cars must not be used for shipments of smokeless powder in water unless equipped with positive closure type bottom outlet valves.

[6] Cylinders made under specification B. E. 27 mounted on or forming part of a car, and classified as multi-unit tank cars prior to October 1, 1930, may be continued in service until further order of the Commission, provided they have been properly retested and are fitted with valves, valve protection devices, and safety devices, of approved type.

[7] Tanks must be restenciled to proper 105A100, 105A100-W or 105A100-AL-W classifications within 2 years from August 31, 1956.

[8] Tanks authorized under I.C.C. Special Orders of November 5, 1937 and November 14, 1939 may be continued in service as provided by Order and revision thereof.

[9] Cars built prior to August 31, 1956 equipped with safety valves having a pressure setting of 35 p.s.i may be used. Cars equipped with 25 p.s.i. safety valves may be continued in service but these valves may not be reset to 35 p.s.i. without changing spring to a design suitable for the increased pressure setting.

[10] Existing tanks built of materials and equipped with fittings complying with these specifications must be restenciled to indicate proper classification.

[11] Cars built prior to August 31, 1956 equipped with safety vents having frangible rupture discs of 30 p.s.i. may be used. Cars equipped with 30 p.s.i. safety vents may be continued in service but these safety vents may be resent to 45 p.s.i. by changing the frangible disc to one of that rating.

(b) Any riveted tank car after repairs requiring extensive riveting or calking must be retested as prescribed in paragraph (g) of this section, before the tank is returned to service.

(c) For detailed procedure to be followed in making repairs or alterations to tanks of all tank car classifications, together with methods of filing application for securing approval from the Secretary of the Mechanical Division, Association of American Railroads, see Appendix R, Association of American Railroads Code for Repairs to Tank Car Hanks.

(d) For repairs to ICC-106A or 110A type of tank or equipment (see §§ 78.275, 78.276, and 78.293) therefor requiring welding, the owner of the tank, or party authorized by the owner, must secure approval from the Association of American Railroads' committee on tank cars of such repairs, and the welding and stress-relieving must be the same as authorized for manufacture of tank. Tank must be retested as prescribed in paragraph (g) of this section, before being returned to service.

(e) A tank car other than of the ICC-106A or 110A and 107A type that bears evidence of damage to the metal by fire must be withdrawn from transportation service: **Provided, however,** That where the damage to the tank is local only or confined to a section not exceeding 25 percent of the tank surface, the damaged material may be replaced.

(1) Tanks of ICC-106A, 110A, and 107A type exposed to the action of fire must not again be placed in service until they have been inspected inside and outside, to determine that no reduction in wall thickness has resulted, and properly heat-treated and retested. These operations must be carried out, supervised, and reported, as prescribed by these specifications for original heat-treatment and test.

(f) After alterations of tank cars or equipment therefor from original design, a certificate of compliance with the specifications, similar to that required in specifications 103, 103-W, 103AL-W, 105A100, 105A100-W, 105A100 AL-W, 105A300-W, 105A300AL-W, 106A500, 107A, and 110A500-W, respectively, must be furnished to the car owner, to the Bureau of Explosives, and to the Secretary, Mechanical Division, Association of American Railroads.

(g) Tanks, interior heater systems and safety valves must be retested at intervals of time as specified in Retest Tables 1, 2 and 3.

(1) Each tank must be retested by completely filling the tank and manway nozzle, or expansion dome, with water or other liquid of similar viscosity having a temperature which must not exceed 100 degrees Fahrenheit during retest and applying a pressure as specified. The specified pressure must be held for the minimum period prescribed without leakage or evidence of distress. Calking of welded joints to stop leaks developed during retests is prohibited. Tanks in service 10 years or over must be internally inspected and interior heater systems inspected for defects which would make leakage or failure probable during transit.

(2) Anchor rivet housings, if used, must not be removed during retest. They shall be retested by applying an air pressure of 100 pounds per square inch through openings in the tank shell and must show no leakage.

(3) The tank lagging and jacket need not be removed unless leakage is indicated by a drop in pressure. When lagging is not removed, the prescribed test pressure must be held for the minimum number of minutes shown in Tables 1 and 3 for tests under this condition.

(4) Interior heater systems shall be retested with hydrostatic pressure and shall be tight at 200 pounds per square inch.

(5) Retests of exterior heater systems is not a specification requirement.

(6) Retest of safety valves: Each valve must be retested by air, or inert gas and must open at the prescribed pressure within tolerances specified or below maximum pressure permitted and must be vapor tight at or above prescribed limits. See Tables 1, 2 and 3.

(7) Repairs: Tanks must be retested before being returned to service after any repairs requiring welding, riveting or calking of rivets. Rubber lined tanks must be retested before lining is renewed. Interior heater systems must be retested after repairs or renewals of any part of heater systems.

(8) Retests of all tanks and safety valves must be certified by party making tests to owners of tank cars and to the Bureau of Explosives. Certifications must show initials and numbers of cars, pressure to which tested, date of test, place of test, and by whom test is made.

TABLE 1—RETEST PERIODS AND PRESSURES

Classification	See Foot Note	Tank retests: Up to 10 years	Tank retests: 10–22 years	Tank retests: Over 10 years	Tank retests: Over 22 years	Safety valve retest years	Interior heater systems retest: Up to 10 years	Interior heater systems retest: 10–22 years	Interior heater systems retest: Over 10 years	Interior heater systems retest: Over 22 years	Tank test psi.	Safety valve psi.c	Safety valve vapor tight psi. min.	Retest holding time min.	Test Time when lagging is not removed min.
ICC-103		10	....	10	....	10	10	....	10	....	60	*35	28	10	20
ICC-103A	d	5	3	....	1	None	5	3	....	1	60	....	....	10	20
ICC-103B	f	None	None	....	None	None	5	3	....	1	60	....	....	....	....
ICC-103C	e, d	5	3	....	1	e	5	3	....	1	60	*45	....	10	20
ICC-104		10	....	10	....	10	10	....	10	....	60	*35	28	10	20
ICC-105	a	10	....	10	....	5	....	....	....	....	500	225	180	30	30
ICC-105A100		10	....	10	....	5	....	....	....	....	100	75	60	10	20
ICC-105A300	a	10	....	10	....	5	....	....	....	....	300	225	180	30	30
ICC-105A400	a	10	....	10	....	5	....	....	....	....	400	300	240	30	30
ICC-105A500	b, a	10	....	10	....	5	....	....	....	....	500	375	300	30	30
ICC-105A600	b, a	10	....	10	....	5	....	....	....	....	600	450	360	30	30
ICC-103-W		10	....	10	....	10	10	....	10	....	60	*35	28	10	20
ICC-103A-W	d	5	3	....	1	None	5	3	....	1	60	....	....	10	20
ICC-103B-W	f	None	None	....	None	None	5	3	....	1	60	....	....	....	....
ICC-103B100-W	f	None	....	None	....	5	....	....	....	....	100	75	60	10	20
ICC-103C-W	e, d	5	3	....	1	e	5	3	....	1	60	35	28	10	20
ICC-103D-W	e, d	5	3	....	1	e	5	3	....	1	60	35	28	10	20
ICC-103E-W	e, d	5	3	....	1	e	5	3	....	1	60	35	28	10	20
ICC-103A-N-W	e, d	5	3	....	1	None	5	3	....	1	60	....	....	10	20
ICC-103AL-W		10	....	10	....	10	10	....	10	....	60	*35	28	10	20
ICC-103A-AL-W	e, d	5	3	....	1	e	5	3	....	1	60	35	28	10	20
ICC-104-W		10	....	10	....	10	10	....	10	....	60	*35	28	10	20
ICC-105A100-AL-W		10	....	10	....	5	10	....	10	....	100	75	60	10	20
ICC-105A300-AL-W		10	....	10	....	5	....	....	....	....	300	225	180	30	30
ICC-105A100-W		10	....	10	....	5	10	....	10	....	100	75	60	10	20
ICC-105A300-W	a	10	....	10	....	5	....	....	....	....	300	225	180	30	30
ICC-105A400-W	a	10	....	10	....	5	....	....	....	....	400	300	240	30	30
ICC-105A500-W	b, a	10	....	10	....	5	....	....	....	....	500	375	300	30	30
ICC-105A600-W	b, a	10	....	10	....	5	....	....	....	....	600	450	360	30	30
ICC-109A-100AL-W		10	....	10	....	5	10	....	10	....	100	75	60	10	20
ICC-109A300-W		10	....	10	....	5	....	....	....	....	300	225	180	30	30

a—Tanks and safety valves in chlorine service must be retested every two years.
b—Special requirements for carbon dioxide—Valves must be retested at pressure required for new construction.
c—Safety valves indicated with * are set at specified pressure plus or minus 3 psi. All other valves must be open at a pressure not exceeding that specified.
d—A commodity for which the tank is approved may be used for filling tank and dome when retesting tanks in service not over 10 years.
e—Safety valve retest period is same as tank retest period.
f—Tanks must be retested before rubber lining is renewed or before being returned to service after any repairs requiring welding, riveting or calking of rivets.

TABLE 2—RETEST PERIODS AND PRESSURES

Classification	Tank retest years a, b	Safety valves years e	Tank test: Holding time minimum sec.	Tank test: Hydrostatic displacement test—psi.	Tank test: Air test for leaks psi.	Safety valve—psi.	Safety valve vapor tight—psi.
ICC-106A500	5	2	30	500	100	375	300
ICC-106A500X	5	2	30	500	100	375	300
ICC-106A800	5	2	30	800	100	600	480
ICC-106A800X	5	2	30	800	100	600	480
ICC-106A800NCI	5	2	30	800	100	600	480
ICC-107A****	5	2f	30	d	None	e	e
ICC-110A500-W	5g	2	10 min.	500 hydrostatic	—	375	300

a—Tank must be condemned when it leaks or permanent expansion exceeds 10% of the total expansion.
b—Reports giving data showing results of these retests must be rendered by the party making the test to the owner of the tank and to the Bureau of Explosives, and each tank passing the test must be marked with the date (month and year) plainly and permanently stamped into the metal of one head or chime. For example, 1-54 for January, 1954. Dates of previous tests must not be obliterated. (On ICC-107A****tanks date should be stamped into metal of marked end.)
c—Safety vents of the frangible disc and fusible plug types must be inspected after each loaded trip of tank as follows; remove at least one vent for visual inspection and if it shows signs of deterioration, all the vents must be removed and inspected and those which do not meet the requirements must be renewed. See Note f for ICC-107A****tanks.
d—Each tank must be tested to a pressure at least equal to the marked test pressure of the tank.
e—Safety valve must open at a pressure not exceeding the marked test pressure of the tank and must be vapor tight at 80 percent of the marked test pressure of the tank.
f—ICC-107A****tanks used for transportation of flammable gases must have safety devices of valve type retested once in every two years as prescribed. When safety devices of frangible disc type are used, one from each car must be tested as prescribed.
g—Tank must be condemned when it leaks or shows evidence of distress during hydrostatic test.

(9) Periodic retests of metal tanks, safety valves and interior heater systems, except cars in chlorine service and tanks to specifications ICC-106A500, 106A500X, 106A800, 106A800X, 106A800NCI, 107A**** or 110A500-W, may be made at any time during the calendar year the retest falls due.

(h) Tank cars and appurtenances may be used for the transportation of any commodity for which they are authorized, as indicated on the certificate of construction. When a car is to be used for the transportation of a commodity other than those approved on the certificate of construction, it must be approved for such loading by the A.A.R. Tank Car Committee. Changes in fittings or commodity stenciling required to transfer a car from one service to another as authorized on the certificates of construction may be made only by the owner or owner's authorized agent; except, that where no change in fittings or other appurtenances is necessary, ICC-103, 103-W, 103AL-W, 103A, 103A-W, 103A-AL-W, 103A-N-W, 103B, 103B-W, 103C, 103C-W, 103D-W, and 103E-W tank cars may be transferred from one commodity service to another when authorized for the transportation of such commodity by this part.

TABLE 3—(AAR CLASSIFICATIONS) RETEST PERIODS AND PRESSURES

Classification	Tank retests				Safety valve retest years	Interior heater systems retest				Tank test psi.	Safety valve psi.b	Safety valve vapor tight psi. min.	Retest holding time min.	Test time when lagging is not removed min.
	Up to 10 years	10–22 years	Over 10 years	Over 22 years		Up to 10 years	10–22 years	Over 10 years	Over 22 years					
ARA-II	....	....	....	10	10	....	....	....	10	60	*25	20	10	20
**ARA-II Acid	....	....	....	1	None	....	....	....	1	60	....	....	10	20
***ARA-II R.L.c	....	....	....	None	None	....	....	....	1	60	....	....	....	....
ARA-III	....	....	....	10	10	....	....	....	10	60	*25	20	10	20
**ARA-III Acid	....	....	....	1	None	....	....	....	1	60	....	....	10	20
***ARA-III R.L.c	....	....	....	None	None	....	....	....	1	60	....	....	....	....
ARA-IV	....	....	....	10	10	....	....	....	10	60	*25	20	10	20
ARA-IVA	....	....	....	10	5	....	....	....	....	100	*35	28	20	20
ARA-V a	....	....	....	10	5	....	....	....	....	300	225	180	30	....
AAR-201A35	10	....	10	....	10	....	....	10	....	35	*15	12	10	....
AAR-203	10	....	10	....	10	....	....	10	....	60	*35	28	10	20
AAR-201A35-W	10	....	10	....	10	....	....	10	....	35	*15	12	10	....
AAR-203-W	10	....	10	....	10	....	....	10	....	60	*35	28	10	20
AAR-205A300-W	10	....	10	....	5	....	....	....	....	300	225	180	30	....
AAR-201A70-W	10	....	10	....	10	....	....	10	....	70	*35	28	10	....

** Unlined acid tanks.
*** Rubber lined tanks.
a—Tanks and safety valves in chlorine service must be retested every two years.
b—Safety valve indicated with * are set at specified pressure plus or minus 3 psi. All other valves must be open at a pressure not exceeding that specified.
c—Tanks must be retested before rubber lining is renewed or before being returned to service after any repairs requiring welding, riveting or calking of rivets.

NOTE 1: For qualification of cylinders and tank cars for compressed gases see §§ 73.34, 73.301 (g), and 73.314.

(i) A tank car that leaks, or that has any defect which would make leakage during transit probable, or that has not been properly tested and marked, must not be used for the transportation of dangerous articles.

(j) Before tank cars are loaded, the shipper must examine the tanks and their appurtenances to see that the safety and outlet valves, the safety vents, the excess flow valves (if any), the closures of all openings, and the protective covers of all appurtenances are in proper condition. Tanks with bottom discharge outlets must have their outlet caps off, or outlet cap plugs open, during entire time tanks are being loaded. After loading, tanks which show any dropping of liquid contents at the seams or rivets, or with bottom outlet valves which permit more than a dropping of the liquid with the outlet caps off, must not be offered for transportation until proper repairs have been made.

(k) Tank cars equipped with interior heater coils must be loaded with heater coil inlet and outlet caps off during entire time tanks are being loaded and show no leakage with these caps off.

(l) All closures of openings in tank cars and of their protective housings must be properly secured in place by the use of a bar, wrench, or other suitable tool. A wrench having a handle at least 36 inches long must be used to apply the outlet valve cap. Manhole covers and outlet valve caps must be made tight against leakage of vapor and liquid, by use of gaskets of suitable materials, before cars are tendered to carrier for transportation. Luting materials must not be used in outlet cap or on threads of bottom outlet.

§ 73.32 Qualification, maintenance, and use of portable tanks. (a) Except as otherwise provided in this section, every portable tank container used for the transportation of dangerous articles shall fulfill the requirements of the specification and regulations for the transportation of the particular commodity. A manufacturer's data report of the portable tank container shall be procured and retained in the files of the owner during the time that such portable tank container is used for such service.

(1) When a portable tank container is used as a cargo tank container, it shall comply with all the requirements prescribed for cargo tank containers. (See § 73.33 of this part.)

(2) Portable tank containers for transportation as cargo on vessels in commerce subject to the jurisdiction of the United States Coast Guard shall not exceed a loaded weight of 8,000 pounds. Nothing contained in this section shall be so construed as to pertain to transportation on car floats or car ferries.

(b) Any portable tank container constructed prior to May 15, 1950, complying with the requirements of either the A.S.M.E. Code for Unfired Pressure Vessels, 1946 Edition, or the A.P.I.A.S.M.E. Code for Unfired Pressure Vessels, 1943 Edition, may be used for the transportation of liquefied compressed gas, provided it fulfills all the requirements of this part and specifications for the particular gas or gases to be transported therein and shall be marked "ICC Specification 51X" on the plate required by the specification, except as modified by any or all of the following:

(1) Tanks designed and constructed in accordance with Pars. U-68, U-69, or U-201 of the A.S.M.E. Code may be used Tanks designed and constructed in accordance with Pars. U-68 or U-69 may be re-rated at a working pressure 25 percent in excess of the design working pressure for which the tank was originally constructed. If advantage is taken of the increased rating, the re-rated pressure shall be marked on the plate as follows:

Re-rated working pressure ———— psig.

NOTE 1: For purposes of setting safety relief valves, pressure control valves and establishing retest pressure, and for purposes of establishing maximum and minimum design working pressures, the re-rated working pressure shall be considered as the equivalent of the design working pressure as defined in the specification.

(2) Loading and unloading accessories, valves, piping, fittings, safety and gauging devices, do not have to comply with the requirements for the particular location on the tank.

(3) Tanks having capacities of between 750 pounds and 1,000 pounds of water shall be considered as portable tank containers for the purposes of this part. In lieu of using safety relief valves on such containers they may be equipped with fusible plugs only when the container is filled by weight. Size, number, and location, as well as character and physical properties of fusible plugs shall be approved by the Bureau of Explosives. These containers shall be marked "ICC Specification 51S."

(4) Specification requirements as to stress-relieving and radiographing are waived.

(c) Any portable tank container of ICC Specification 50[2] fulfilling the requirements of that specification may be continued in service for transportation of a liquefied petroleum gas if it is retested every five years in accordance with the requirements of paragraph (e) (3), (4), and (5) or this section: **Provided,** That it is in and can be maintained in safe operating condition for the transportation of that gas. In this case the container may retain its original markings.

(d) Fusion welded portable tanks manufactured prior to July 19, 1948, in complete compliance with specifications included in ICC Authority No. 3666 dated December 28, 1939 (235 I. C. C. 595),[2] are authorized for the transportation of commercial butane: **Provided,** That they are in and can be maintained in safe operating condition for the transportation of that gas and are retested every five years in accordance with the requirements of paragraph (e) (3), (4), and (5) of this section. Certificate of manufacture for each tank and record of each required five year retest is filed with the Bureau of Explosives, and in addition to the markings prescribed by the aforementioned authority each tank is permanently marked "ICC-50X." (See Appendix A to Subpart C of Part 78.)

(e) Portable tank containers used for the transportation of dangerous articles shall be retested in accordance with the following and shall not be kept in or returned to transportation service unless they shall have successfully withstood the following prescribed tests, as appropriate in each instance:

(1) Every portable tank container manufactured in accordance with ICC Specification 60 shall be tested at the end of the first 4 year period after the original test and each 2 years thereafter up to 12 years of service and annually thereafter. Except that retests are not required on such tanks equipped with rubber lining but retests must be made before such tanks are relined. Retest of Specification 60 tanks to be as required in §78.255-12 of Specification 60 for new tank.

(2) Every portable tank container which is constructed in accordance with ICC Specification 51, or qualified for transporting compressed gases as prescribed in these regulations shall be tested at least once in every five years in accordance with paragraph (e) (3), (4), and (5) of this section.

(3) The tank less any fittings shall be subjected to a hydrostatic pressure of one and one half times the design working pressure (maximum permitted working pressure or re-rated pressure) of the tank.

(4) While under test pressure the tank shall be inspected for leakage, corroded areas, bad dents or other conditions which indicate weakness that might render the tank unsafe for transportation service and shall be rejected if evidence of any such unsafe condition is discovered.

(5) The tank lagging, if any, and its jacket need not be removed from lagged tanks unless it is found to be impossible to reach test pressure and maintain a condition of pressure equilibrium after test pressure is reached during tank retesting.

(f) Every tank not complying in all respects with prescribed specifications, but otherwise allowable under this part, shall successfully withstand the identical tests at test periods required for "specification tanks" by paragraph (e) (3), (4), and (5) of this section. Tanks constructed in accordance with paragraph U-68 or U-69 of the A.S.M.E. Code, and which have not been re-rated, must be retested at hydrostatic pressure of twice the design working pressure.

(g) Without regard to any other retest requirement, any tank that shows evidence at any time of bad dents, corroded areas, leakage or other conditions that indicate weakness which might render the tank unsafe for transportation service, shall be retested as prescribed by the requirements of paragraph (e) (3), (4), and (5) of this section.

(h) Any tank which has been in an accident and which has been damaged to an extent likely to cause it to be in unsafe condition or to an extent where such a condition is suspected, shall be tested as prescribed by the requirements of paragraph (e) (3), (4), and (5) of this section.

(i) Any tank which has been out of transportation service for a period of one year or more shall not be returned to or placed in such service until it shall have successfully fulfilled the testing requirements prescribed in paragraph (e) (3), (4), (5) of this section.

(j) The Commission may require the testing under prescribed conditions of any tank when probable cause appears for suspecting that such tank is in unsafe operating condition.

(k) The repair of tanks is authorized, provided such repairs are made under requirements prescribed in the "Code" for the original design and construction.

(l) In addition to any other provisions of the specification, no tank shall be repaired, or remodeled, as to cause leakage or cracks or likelihood of leakage or cracks, by areas of stress concentration due to shrinkage of cooling metal in welding operations, sharp fillets, reversal of stresses, or otherwise.

(2) No field welding shall be done except to non-pressure parts.

(1) The bursting strength of any piping and fittings shall be not less than four times the design working pressure of the tank, and not less than four times that pressure to which, in any instance, it may be subjected in service, by the action of a pump or other device (not including safety relief valves) the action of which may be to subject certain portions of the tank piping to pressures greater than the design working pressure of the tank.

(1) Welded pipe joints shall be used wherever possible. Joints in copper tubing where permitted shall be of the brazed type or of any equally strong metal union type. Melting point of brazing material must be not less than 1,000°F. Such joints shall in any event be of such a character as not to decrease the strength of the tubing, as by the cutting of threads.

(2) Fittings shall be extra heavy. Non-malleable metals shall not be employed in the construction of valves or fittings.

(3) Suitable provision shall be made in every case to allow for expansion, contraction, jarring and vibration of all pipe. Slip joints shall not be used for this purpose.

(4) Piping and fittings shall be grouped in the smallest practicable space and shall be protected from damage as required by the specification.

(5) All piping, valves and fittings on every tank shall be leakage tested with gas or air after installation and proved tight at not less than the design working pressure of the tank on which they are used. In the event of replacement, all such piping, valves, or fittings so replaced shall be tested in accordance with the requirements of this section before the tank is returned to transportation service. The requirements of this section shall apply with equal force to all hose used on such tanks, except that such hose may be so tested either before or after installation on the tank.

(m) All materials of construction used in portable tank containers and their appurtenances shall not be subject to destructive attack by the contents of the tank.

(1) All parts of tanks and appurtenances for anhydrous ammonia shall be steel. No copper, silver, zinc, nor their alloys shall be permitted. Brazed joints shall not be permitted.

(n) Each outlet of portable tanks used for the transportation of liquefied compressed gases, except carbon dioxide, shall be provided with a suitable automatic excess-flow valve. These valves shall be located inside the tank or at a point outside the tank where the line enters or leaves the tank. The valve seat shall be located inside the tank or shall be located within a welded flange or its companion flange, or within a nozzle, or within a coupling. The installation shall be made in such a manner as reasonably to assure that any undue strain which causes failure requiring functioning of the valve shall cause failure in such a manner that it will not impair the operation of the valve.

Exception. Safety device connections and liquid level gauging devices which are so constructed that the outward flow of tank contents shall not exceed that passed by a No. 54 drill size opening are not required to be equipped with excess-flow valves.

(1) Excess-flow valves shall close automatically at the rated flows of gas or liquid as specified by the vavle manufacturer. The connections or lines on each side of the excess-flow valve, including valves, fittings, etc., shall have a greater capacity than the rated flow of the excess-flow valve.

(2) Excess-flow valves may be designed with a by-pass, not to exceed a No. 60 drill size opening, to allow equalization of pressures.

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[2] Use of existing portable tanks authorized, but new construction not authorized.

(3) Filling and discharge lines shall be provided with manually operated shut-off valves located as close to the tank as is practicable. The use of so-called "Stop-Check" valves to satisfy with one valve the requirements of this subparagrgraph and of paragraph (n) of this section, is forbidden.

(o) Each tank for carbon dioxide and nitrous oxide shall be lagged with a suitable insulation material of such thickness that the overall thermal conductance is not more than 0.08 Btu per square foot per degree F. differential in temperature per hour. The conductance shall be determined at 60°F. In no event shall less than 4 inches of thickness of insulation be used. Insulation material used on tanks for nitrous oxide shall be noncombustible.

(p) A refrigerating and/or heating coil or coils may be installed in tanks for carbon dioxide and nitrous oxide. Such coils must be tested externally to at least the same pressure as the test pressure of the tank. The coils must also be tested internally to at least twice the working pressure of the heating or refrigerating system to be used but in no case less than the test pressure of the tank. Such coils shall be securely anchored. The refrigerant or heating medium to be circulated through the coil or coils must be such as to cause no adverse chemical reaction with the tank or tank contents in case of leakage.

§ 73.33 Qualification, maintenance, and use of cargo tanks. (a) Except as otherwise provided in this section, every cargo tank used for the transportation of dangerous articles shall fulfill the requirements of the specification and regulations for the transportation of the particular commodity. A manufacturer's data report of the cargo tank shall be procured and retained in the files of the motor carrier during the time that such cargo tank is used for such service.

(1) Cargo tank containers for transportation as cargo on vessels in commerce subject to the jurisdiction of the United States Coast Guard shall not exceed a loaded weight of 8,000 pounds. Nothing contained in this section shall be so construed as to pertain to transportation on car floats or car ferries.

(2) Cargo tanks to be used for the transportation of corrosive or flammable liquids shall be of the types prescribed by the regulations and maintained or retested in accord with the requirements appearing in such specifications.

(b) Any cargo tank constructed prior to May 15, 1950, complying with the requirements of either the A.S.M.E. Code for Unfired Pressure Vessels, 1946 Edition, or the A. P.I.-A. S. M. E. Code for Unfired Pressure Vessels, 1943 Edition, for the transportation of liquefied compressed gases, may be used in that service, if it is retested every five years in accordance with the requirements of paragraph (k) (2), (3), and (4) of this section: **Provided,** It fulfills all the requirements of the regulations and specifications for cargo tanks for the transportation of the particular gas or gases to be transported therein, except in regard to the provisions of paragraph (b) (1) or (2) of this section, and shall be marked "ICC Specification MC330X" on the plate required by Specification MC330.

(1) Tanks designed and constructed in accordance with pars. U-68 or U-69 of the A. S. M. E. Code for the transportation of liquefied compressed gases may be used and may be re-rated at a working pressure 25 percent in excess of the design working pressure for which the tank was originally constructed. If advantage is taken of the increased rating, the re-rated pressure shall be marked on the plate as follows:

Re-rated working pressure ———— psig.

NOTE 1: For purposes of setting safety relief valves and pressure control valves, and for purposes of establishing maximum and minimum design working pressures, the re-rated working pressure shall be considered as the equivalent of the design working pressure as defined in the specification.

(2) Loading and unloading accessories, valves, piping, fittings, safety and gauging devices, do not have to comply with the requirements for the particular location on the tank.

(c) Any cargo tank of ICC Specification MC 320[1] constructed or put in service on and after February 1, 1942, and prior to May 15, 1950, fulfilling the requirements of that specification may be continued in service for the transportation of any compressed gas for which specification MC 330 tanks are authorized if it is retested every five years in accordance with the requirements of paragraphs (k) (2), (3), and (4) of this section: **Provided,** That it is in and can be maintained in safe operating condition for the transportation of that gas, and shall be marked "ICC Specification MC 320" on the plate required by specification MC 330.

(d) Any cargo tank of ICC Specification 7.6-S-1.2,[1] constructed or put into service on and after June 15, 1940, and prior to February 1, 1942, fulfilling the requirements of that specification may be continued in service for the transportation of a liquefied petroleum gas if it is retested every five years in accordance with the requirements of paragraph (k) (2), (3), and (4) of this section: **Provided,** That it is in and can be maintained in safe operating condition for the transportation of that gas, and shall be marked "ICC Specification MC-7.6-S-1.2" on the plate required by Specification MC330.

(e) Any cargo tank constructed prior to June 15, 1940, in accordance with either the A. S. M. E. or A. P. I.-A. S M. E. Code for Unfired Pressure Vessels effective at the time of fabrication, and previously authorized under ICC Specification MC320,[1] may be continued in service for the transportation of a liquefied petroleum gas if retested annually in accordance with paragraph (k) (2), (3), and (4) of this section: **Provided,** That it is in and can be maintained in safe operating condition for the transportation of that gas and shall be marked "ICC Specification MC320Y" on the plate required by Specification MC330.

(f) Any cargo tank constructed other than prescribed in paragraphs (c), (d), and (e) of this section, and previously authorized under ICC Specification MC320,[1] may remain in service for the transportation of a liquefied petroleum gas only: **Provided,** That it is retested annually in accordance with the requirements of paragraph (k) (2), (3), and (4) of this section: **Provided,** That it is in and can be maintained in safe operating condition for the transportation of that gas: **Further provided,** That it must be equipped with all the safety devices and fittings required under this section and ICC Specification MC330 for the transportation of that gas, although they need not be mounted all in one place as required therein but must be adequately protected against the hazards of collision, overturn, or both, and, in addition, must be marked "ICC Specification MC320Z" on the plate required by Specification MC330.

(g) Cargo tanks of the specifications shown in subparagraph (1) of this paragraph, made prior to December 31, 1953, authorized for use under regulations of the Commission effective March 1, 1935, those effective June 15, 1940, or February 1, 1942, may be continued in use as previously authorized until further order of the Commission. Tanks now under construction under specification MC 310 may be so marked.

(1) Where these regulations call for specification numbers:	Containers made under the following specifications may also be used:
MC 200	7.2-S-1
MC 201	7.2
MC 300	7.3-S-1.2
MC 301	7.3-S-1.3
MC 302	7.3-S-1.4
MC 303	7.3-S-1.5
MC 310	7.5-S-1.2
MC 311	MC 310 and 7.5-S-1.2
MC 330	MC 320

(h) Any novel cargo tank which has been or may be authorized for the transportation of a particular dangerous article may be continued in or placed in service only under the terms specifically prescribed by the Commission.

(i) Notwithstanding any of the provisions of paragraphs (a) to (h) of this section, any cargo tank constructed prior to May 15, 1950, which can qualify under and fulfill all of the requirements of any of the specifications and regulations for cargo tanks prescribed for the transportation of a particular dangerous article may be put into service and marked under the terms of such specification.

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[1] Use of existing cargo tanks authorized, but new construction not authorized.

(j) The Commission may, upon written request for such authorization by a motor carrier, authorize the use of limited numbers, and for limited times, of new cargo tanks which fail to meet the requirements of the specification for cargo tanks contained in Part 78. In the event of such request for authorization, the carrier shall furnish those details concerning the design and construction of the tank motor vehicle and the cargo tank as seem necessary for the determination of its ability to transport safely the proposed commodity.

(k) Cargo tanks used for transportation of liquefied compressed gases shall be retested in accordance with the following and shall not be kept in or returned to transportation service unless they shall have successfully withstood the following prescribed tests, as appropriate in each instance:

(1) Every cargo tank which is constructed in accordance with or fulfilling the requirements of ICC Specification MC 330 shall be tested at least once in every five years in accordance with paragraphs (k) (2), (3), and (4) of this section, except that tanks and safety valves of cargo tanks used for the transportation of chlorine must be retested at intervals of two years or less.

(2) The tank less any fittings shall be subjected to a hydrostatic pressure of one and one-half times the design working pressure (maximum permitted working pressure or re-rated pressure) of the tank.

(3) The tank shall be inspected for corroded areas, bad dents, or other conditions, including leakage under test pressure, which indicate weakness that might render the tank unsafe for transportation service, and shall be rejected if evidence of any such unsafe condition is discovered.

(4) The tank lagging, if any, and its jacket need not be removed from lagged tanks unless it is found to be impossible to reach test pressure and maintain a condition of pressure equilibrium after test pressure is reached during tank retesting.

(5) Every tank not complying in all respects with the prescribed specifications, but otherwise allowable under this part, shall successfully withstand the identical tests at test periods required for "specification tanks" by paragraph (k) (2), (3), and (4) of this section. Nonspecification tanks (paragraphs (e) and (f) of this section) shall be tested at least once in every calendar year as required in paragraph (k) (2), (3), and (4) of this section. Tanks constructed in accordance with Pars. U-68 or U-69 of the A. S. M. E. Code, and which have not been re-rated, must be retested at a hydrostatic pressure of twice the design working pressure.

(6) Every cargo tank which shall have been authorized by the Commission to transport dangerous articles under the provisions of paragraph (j) of this section shall be tested under requirements specifically set forth in the terms of such authorization.

(7) Without regard to any other retest requirement, any tank that shows evidence at any time of bad dents, corroded areas, leakage, or other conditions that indicate weakness which might render the tank unsafe for transportation service, shall be retested as prescribed by paragraph (k) (2), (3), and (4) of this section.

(8) Any tank which has been in an accident and which has been damaged to an extent likely to cause it to be in unsafe condition or to an extent where such a condition is suspected, shall be tested as prescribed by paragraph (k) (2), (3), and (4) of this section.

(9) Any tank which has been out of transportation service for a period of one year or more shall not be returned to or placed in such service until it shall have successfully fulfilled the testing requirements prescribed by paragraph (k) (2), (3), and (4) of this section.

(10) The Commission may require the testing under prescribed conditions of any tank when probable cause appears for suspecting that such tank is in unsafe condition.

(11) Every cargo tank authorized for the transportation of flammable liquids and/or corrosive liquids under specifications MC300 to MC304 inclusive, MC310, or MC311 must be retested as provided in the applicable specification, except that retests not required on tanks equipped with rubber lining but retests must be made before such tanks are relined.

(l) The repair of tanks is authorized, provided such repairs are made under requirements prescribed in the "Code" for its original design and construction.

(1) In addition to any other provisions of the specification, no tank shall be repaired, or remodeled, as to cause leakage or cracks or likelihood of leakage or cracks, by areas of stress concentration due to shrinkage of cooling metal in welding operations, sharp fillets, reversal of stresses, or otherwise.

(2) No field welding shall be done except to nonpressure parts.

(m) On tanks used for compressed gases (except chlorine for which provisions are made at sub-paragraphs (m) (9) to (m) (11) of this section), the bursting strength of any piping and fittings shall be not less than four times the design working pressure of the tank, and not less than four times that pressure to which, in any instance, it may be subjected in service, by the action of a pump or other device (not including safety relief valves) the action of which may be to subject certain portions of the tank piping to pressures greater than the design working pressure of the tank.

(1) Welded pipe joints shall be used wherever possible. Joints in copper tubing shall be of the brazed type where permitted or of any equally strong metal union type. Melting point of brazing material must be not less than 1000°F. Such joints shall in any event be of such a character as not to decrease the strength of the tubing, as by the cutting of threads.

(2) Fittings shall be extra heavy. Non-malleable metals shall not be employed in the construction of valves or fittings.

(3) Suitable provision shall be made in every case to allow for expansion, contraction, jarring, and vibration of all pipe. Slip joints shall not be used for this purpose.

(4) Piping and fittings shall be grouped in the smallest practicable space and shall be protected from damage as required by the specification.

(5) All hose, wherever used, shall be designed for a bursting pressure not less than four times the design working pressure of the tank with which it is used, and not less than four times that pressure to which, in any instance, it may be subjected in service by the action of a pump or other device, the action of which may be to subject the hose to pressures greater than the design working pressure of the tank. Any coupling used on hose to make connections shall be designed for a working pressure, not less than 20 percent in excess of the design working pressure of the hose, and shall be so designed that there will be no leakage when connected.

(6) All piping, valves, and fittings on every tank motor vehicle shall be proved free from leaks at not less than the design working pressure for the tank. This condition will be considered to have been met when such piping, valves, and fittings have been tested for leakage with gas or air after installation and proved tight at not less than the design working pressure marked on the cargo tank with which they are used. In the event of replacement, all such piping, valves, or fittings so replaced shall be tested in accordance with the requirements of this section before the tank is returned to transportation service. The requirements of this section shall apply with equal force to all hose used on such tanks, except that such hose may be so tested either before or after installation on the tank.

(7) Liquid pumps or gas compressors, wherever used, must be of suitable design, adequately protected against breakage by collisions, and kept in good condition. They may be driven by motor vehicle power take-off or other mechanical, electrical, or hydraulic means. Unless they are of the centrifugal type, they shall be equipped with suitable pressure actuated by-pass valves permitting flow from discharge to suction or to the tank. Liquid pumps shall not be used on tanks for the shipment of sulphur dioxide.

(8) Each tank used for the shipment of carbon dioxide or nitrous oxide shall be provided with a suitable pressure gauge. A shut-off valve must be installed between the pressure gauge and the tank. This gauge need be used only during the filling operation.

(9) On cargo tank motor vehicles for the transportation of chlorine, no piping, hose, or other means of loading or unloading shall be attached to the angle valves required by § 73.33 (o) (4) except at the time of loading or unloading, nor shall any hose, piping, or tubing used for loading or unloading be mounted on or carried on the vehicle nor shall such devices be considered as part of the cargo tank motor vehicle. On cargo tank motor vehicles for the transportation of chlorine, except at the time of loading or unloading, pipe connections of the angle valves must be closed with screw plugs, chained or otherwise fastened to prevent misplacement.

(10) Angle valves on chlorine cargo tank motor vehicles shall be tested at not less than 225 psig, using dry air or inert gas, before installation of such valves on the cargo tank, and such tests shall be made before each loading. The valves and gasketed joints shall be inspected for leaks, at a pressure of not less than 50 psig, after loading and prior to shipment, and such inspections shall be made for each loading. Leaks which are detected shall be corrected before the cargo tank motor vehicle is shipped.

(11) Liquid chlorine pumps shall not be installed on cargo tank motor vehicles used for the shipment of chlorine.

(n) All materials of construction used in cargo tanks and their appurtenances shall not be subject to destructive attack by the contents of the tank.

(1) All parts of tanks and appurtenances for anhydrous ammonia shall be steel. No copper, silver, zinc, nor their alloys shall be permitted. Brazed joints shall not be permitted.

(o) Each outlet of cargo tanks used for the transportation of liquefied compressed gases, except carbon dioxide, shall be provided with an approved suitable automatic excess-flow valve or in lieu thereof may be fitted with an approved automatic quick-closing internal valve. These valves shall be located inside the tank or at a point outside the tank where the line enters or leaves the tank. The valve seat shall be located inside the tank or shall be located within a welded flange or its companion flange, or within a nozzle, or within a coupling. The installation shall be made in such a manner as reasonably to assure that any undue strain which causes failure requiring functioning of the valve shall cause failure in such a manner that it will not impair the operation of the valve.

Exception. Safety device connections and liquid level gauging devices which are so constructed that the outward flow of tank contents shall not exceed that passed by a No. 54 drill size opening are not required to be equipped with excess-flow valves.

(1) Excess-flow valves shall close automatically at the rated flows of gas or liquid as specified by the valve manufacturer. The connections or lines on each side of the excess-flow valve, including valves, fittings, etc., shall have a greater capacity than the rated flow of the excess-flow valve.

(2) Excess-flow valves may be designed with a by-pass, not to exceed a No. 60 drill size opening, to allow equalization of pressures.

(3) Filling and discharge lines shall be provided with a shut-off valve located as close to the tank as is practicable, except where an automatic quick-closing internal valve or an automatic shut-off valve is used, in which case a manually operated shut-off valve shall be located anywhere in the line ahead of the hose connection.

NOTE 1: The use of so-called "STOP-CHECK" or excess flow valves to satisfy with one valve the requirements of this rule and of paragraph (o) of this section is forbidden.

(4) Angle valves and excess-flow valves on chlorine tank motor vehicles shall conform to the standards of The Chlorine Institute, Inc. Angle valve to conform with Dwg. 6-B-347, dated January 24, 1950; excess-flow valve to conform with Dwg. S-20099-M, dated January 30, 1948. An excess-flow valve shall be installed under each angle valve.

(p) Each tank for chlorine, carbon dioxide and nitrous oxide shall be lagged with a suitable insulation material of such thickness that the over-all thermal conductance is not more than 0.08 Btu per square foot per degree F. differential in temperature per hour. The conductance shall be determined at 60°F. In no event shall less than 4 inches of thickness of insulation be used. Insulation material used on tanks for nitrous oxide shall be noncombustible. Insulation material used on tanks for chlorine shall be corkboard.

(q) A refrigerating and/or heating coil or coils may be installed in tanks for carbon dioxide and nitrous oxide. Such coils must be tested externally to at least the same pressure as the test pressure of the tank. The coils must also be tested internally to at least twice the working pressure of the heating or refrigerating system to be used but in no case less than the test pressure of the tank. Such coils shall be securely anchored. The refrigerant or heating medium to be circulated through the coil or coils must be such as to cause no adverse chemical reaction with the tank or tank contents in case of leakage. If desired, the unit furnishing refrigeration may be mounted on the motor vehicle.

§73.34 Qualification, maintenance, and use of cylinders. (a) Cylinders in domestic use previous to the date upon which specifications therefor were first made effective may be used if the cylinders have been properly tested and otherwise comply with the requirements of paragraphs (b) to (k) of this section.

(b) Cylinders of foreign manufacture, received from foreign countries for charging with compressed gas, may be charged and shipped for export only.

(1) **Provided**, They are retested in accordance with paragraph (j) of this section. This retest may be omitted only if the cylinder can be definitely identified as having been retested under this provision within the prescribed retest period.

(2) **Provided further**, That the maximum filling density and service pressure for each cylinder shall be in accordance with all packing requirements of this part for the compressed gas involved and the test pressure established by the retest of the cylinder.

(3) Records giving data showing the results of the tests made on all cylinders must be preserved for inspection for at least 5 years.

(4) Bill of lading or other shipping paper shall, when possible, identify the cylinder and shall carry the following certification: "These cylinders have been retested and refilled in accordance with the I. C. C. requirements for export."

(c) Cylinders previously used in any service in accordance with this part may be transferred to a service requiring less strength and for which they are suitable, upon application to the Bureau of Explosives and receipt of advice to change the marking on the cylinders.

(d) Cylinders made prior to October 1, 1930, for which steel manufacturer's certificates are not available but for which physical and chemical tests on samples taken from one out of each 200 cylinders are in proper form, each cylinder having been satisfactorily tested in water-jacket apparatus to 2 times the service pressure (see § 73.301 (g) of this part), properly reported as otherwise in full compliance with spec. 7[1] effective at date of manufacture, and lawfully marked ICC-7-150[1], are authorized for use under the provisions of this part.

(e) When containers with a marked pressure limit are prescribed, other containers made under the same specification, but with a higher marked pressure limit are authorized. For example, containers marked ICC-4B500 may be used where ICC-4B300 is specified.

(f) **Safety relief devices.** Each cylinder charged with compressed gas, unless excepted in this paragraph, must be equipped with one or more safety relief devices approved, as to type, location, and quantity, by the Bureau of Explosives and must be capable of preventing explosion of the normally charged cylinder when it is placed in a fire. (Cylinders shall not be shipped with leaking safety relief devices. Safety relief devices must be tested for leaks before the charged cylinder is shipped from the cylinder filling plant; it is expressly forbidden to repair leaking fuse plug devices, where leak is through the fusible metal or between the fusible metal and the opening in the plug body, except by removal of the device and replacement of the fusible metal.) Exceptions are as follows:

(1) Except as provided in Notes 1, 2 and 3, safety relief devices are not required on cylinders 12″ or less in length, exclusive of neck, and 4½″ or less in outside diameter.

NOTE 1: Safety relief devices are required on spec. 9, 40, and 41 cylinders.

NOTE 2: Safety relief devices are required on cylinders charged with a liquefied gas for which this part requires a service pressure of 1800 pounds per square inch or higher.

NOTE 3: Safety relief devices are required on cylinders charged with nonliquefied gases to a pressure of 1800 pounds per square inch or higher at 70°F.

(2) Safety relief devices are not required on cylinders charged with nonliquefied gas under pressure of 300 pounds per square inch or less at 70°F.

(3) Safety relief devices are prohibited on cylinders charged with poisonous gas or liquid as defined in § 73.326 (a).

(4) Safety relief devices are prohibited on cylinders charged with fluorine.

(5) Safety relief devices are not required on cylinders charged with methyl mercaptan; mono, di, or trimethylamine, anhydrous; with not over 10 pounds of nitrosyl chloride; or with less than 165 pounds of anhydrous ammonia.

(6) Safety relief devices are not required on drums containing liquefied petroleum gas as provided for in §73.312 (a).

(g) Marking on cylinders must not be changed except as follows:

(1) By application of additional marks not affecting the test pressure or filling pressure; these must not obliterate previously applied marks.

(2) By application of test pressure or filling pressure marks, or alteration of such marks, to indicate a reduced test and filling pressure; authorized only for cylinders that have not failed in the quinquennial test.

(3) By change of serial numbers or ownership marks or both; before remarking, report must be filed with the Bureau of Explosives, in sufficient detail and arranged consecutively according to registered ownership symbol and serial or lot numbers, so that specification marking, previous serial number, registered ownership symbol, and original test date can be determined for each cylinder.

(4) By change in marks which indicate compliance with specifications and charging and testing pressures (such as ICC-3, ICC-3A-1800) to indicate a higher test and filling pressure; authorized only upon written instructions from the Bureau of Explosives.

(5) When restrictions imposed by §73.304 of this part will result in condemnation of cylinders previously in authorized use, the Bureau of Explosives shall, upon application, approve change in marks for pressures not greater than as follows: ICC-7-70 for change to ICC-7-116; ICC-26-150 for change to ICC-26-300; ICC-26-300 for change to ICC-26-450; ICC-26-600 for change to ICC-26-900; ICC-26-1000 for change to ICC-26-1200.

(6) When the space originally provided for dates of subsequent retests becomes filled, the stamping of additional test dates into the external surface of footrings of cylinders is authorized.

(7) Marking on cylinders must be kept plain. All prescribed markings on cylinders must be maintained in a readable condition, or a copy of said markings reproduced by stamping on brass plates permanently secured to the cylinders is permitted.

(h) **Cylinders exposed to the action of fire.** Cylinders which have been in a fire must not again be placed in service until they have been properly heat treated and retested as prescribed in paragraph (i) of this section: **Provided,** That cylinders made of plain carbon steel with not over 0.25 percent carbon need not be heat treated, and may be used after passing the pressure test prescribed. Acetylene cylinders, except those authorized in specification ICC-8, to be made of 4130X steel and those made to comply with specification 8AL, need not be treated or tested, provided porous filling is found to be unchanged and intact. The inner cylinders made under specification 4L may be used after again passing the original hydrostatic test.

(i) **Reheat treatment and retest of cylinders.** The reheat treatment of cylinders must be followed by hydrostatic retest and these operations must be carried out, supervised, and reported, as prescribed for the original heat treatment and hydrostatic test by the specification covering the manufacture of the type of cylinder in question. The retest pressure shall be as prescribed for the quinquennial retesting of cylinder: **Provided,** That increased retest pressure is authorized under testing procedure approved in writing by the Bureau of Explosives. In the case of cylinders of outside diameter exceeding 4 inches, a permanent expansion of not less than 3 percent or more than 10 percent of the total expansion must be shown in the retest: **Provided,** That if the cylinders can be segregated into lots having practically the same chemical composition, the allowable permanent expansion in the retest may be from zero to 10 percent of the total expansion, if one cylinder out of each such lot of 100 cylinders or less is subjected to and passes the requirements of the flattening and physical tests as specified by the specification for the manufacture of the type of cylinder in question.

(j) **Quinquennial retest of cylinders.** Each cylinder, except as specifically exempted in paragraph (k) of this section, must be subjected, at least once in five years, to a test by interior hydrostatic pressure in a water jacket, or other apparatus of suitable form, for the determination of the expansion of the cylinder. The test apparatus must be approved as to type and operation by the Bureau of Explosives. This periodic retest must include a visual internal and external examination, except that the internal inspection may be omitted for cylinders of the type and in the service described under paragraph (k) (11) of this section: **Provided,** That without regard to date of previous test, cylinders of ICC-4 type that show bad dents or other evidence of rough usage, or that are corroded locally to such extent as to indicate possible weakness, or that have lost as much as 5 percent of their official tare weight, must be retested before being again charged and shipped. After any retest, the actual tare weight for those cylinders passing the test may be recorded as their new official tare weight.

(1) In hydrostatic retesting of a cylinder the pressure must be maintained for at least 30 seconds and as much longer as may be necessary to secure complete expansion of the cylinder. The gauge indicating the total expansion of the cylinder must be such that the total expansion can be read with an accuracy of 1 percent, except that a reading to 0.1 cubic centimeter shall be acceptable. The gauge indicating the pressure must be capable of being read to within 1 percent of the test pressure. Any internal pressure applied previous to the test pressure shall not exceed 90 percent of the test pressure. If, due to failure of the test apparatus, the test pressure cannot be maintained, the test may be repeated at a pressure increased by 10 percent or 100 pounds per square inch, whichever is the lower value.

(2) A cylinder must be condemned when it leaks, or when internal or external corrosion, denting, bulging, or evidence of rough usage exists to the extent that the cylinder is likely to be weakened appreciably or when the permanent expansion exceeds 10 percent of the total expansion. A cylinder condemned for excessive permanent expansion may be re-heat-treated. (See paragraph (i) of this section). ICC-4 series cylinders, condemned for other than excessive permanent expansion may be repaired or rebuilt as prescribed in paragraphs (m), (n), (o), and (p), of this section.

(3) Records giving data showing the results of the tests made on all cylinders must be kept, and each cylinder passing the test must be marked with the date (month and year) plainly and permanently stamped into the metal of the cylinder. For example, 4-50 for April 1950. Dates of previous tests must not be obliterated.

(k) The tests prescribed by paragraph (j) of this section must be in accordance with the following table and exceptions thereto.

Specification under which cylinders were made	Minimum retest pressure (pounds per square inch)
ICC-3	3,000 pounds.
ICC-3A; ICC-3AA; ICC-3D; ICC-4A; ICC-26 marked for filling at over 450 pounds	5/3 times the service pressure. (See § 73.301 (g).)
ICC-3B; ICC-3BN; ICC-4AA480; ICC-4B; ICC-4BA; ICC-4D; ICC-4DA; ICC-26 marked for filling at 450 pounds and below	2 times the service pressure. (See § 73.301 (g).)
ICC-3C; ICC-3E; ICC-4C; ICC-4L; ICC-8; ICC-8AL	Quinquennial test not required.
ICC-7 when used as authorized in § 73.312 (a) (4)	300 pounds.
ICC-7 when not used under authority of § 73.312 (a) (4)	Quinquennial test not required.
ICC-4	700 pounds.
ICC-9	400 pounds.
ICC-25; ICC-38	500 pounds.
ICC-33	800 pounds.

Exceptions. (1) All cylinders not exceeding 2 inches outside diameter and length less than 2 feet are exempted from retest.

(2) All cylinders marked with a test pressure must be retested at that pressure.

(3) High-pressure cylinders (designed for pressures in excess of 300 pounds at 70°F.) made before March 31, 1912, and not marked with a test pressure or with an allowable filling pressure, must be retested at 3,000 pounds per square inch.

(4) Low-pressure cylinders of the I. C. C. 7[1] type (designed for nonliquefied gas at not over 300 pounds at 70°F.) made before March 31, 1912, must be tested once at two times the filling pressure for which they were designed. Further tests not required.

(5) Acetylene cylinders of the I. C. C. 8 type made before March 31, 1912, must be tested once at 500 pounds. Further tests not required.

(7) Cylinders made after January 1, 1920, in compliance with specification I.C.C. 4 may be retested decennially instead of quinquennially if the test is made at a pressure of not less than 700 pounds per square inch.

(8) Chlorine and sulfur dioxide cylinders made before April 20, 1915, must be retested at 500 pounds per square inch.

(9) Cylinders of not over 10 pounds water capacity and authorized for a service pressure (see § 73.301 (g) of this part) of not over 300 pounds per square inch may be tested by application of required test pressure without the use of special apparatus and without determination of total or permanent expansion.

(10) ICC-9 cylinders must be tested in accordance with the requirements of §§ 78.63-13 (a) and 78.63-17 (a) (2).

(11) Cylinders made in compliance with specifications ICC-4B, ICC-4BA, and ICC-26-300[1], used exclusively for anhydrous dimethylamine, anhydrous monomethylamine, anhydrous trimethylamine, methyl chloride, or liquefied petroleum gas, or dichlorodifluoromethane, difluoroethane, difluoromonochloroethane, monochlorodifluoromethane, monochlorotetrafluoroethane, monochlorotrifluoroethylene or mixtures thereof or mixtures of one or more with trichloromonofluoromethane, commercially free from corroding components, and protected externally by suitable corrosion resisting coatings (such as galvanizing, painting, etc.) may be retested decennially (see Note 2) instead of quinquennially, or, such cylinders may be subjected to an internal hydrostatic pressure equal to at least 2 times the marked service pressure without determination of expansions (see Note 1), but this type of test must be repeated quinquennially after expiration of the first ten-year period (see Note 2). When subjected to this latter test cylinders must be carefully examined under the test pressure and removed from service if leaks or other harmful defects exist. All tests must be supplemented by a very careful examination of the cylinder at each filling, and the cylinder must be rejected if evidence is found of bad dents, corroded areas, a leak or other conditions that indicate possible weakness which would render the cylinder unfit for service.

NOTE 1: Cylinders tested by the modified hydrostatic method shall be marked after each retest with the date of test as otherwise required but followed by the symbol S; for example, 8-46S indicating retest by the modified method in August 1946.

NOTE 2: Due to the present emergency and until further order of the Commission, the decennial retest period may be extended to a twelve-year period, and the quinquennial retest period may be extended to a seven-year period after expiration of the first twelve-year period.

(12) Cylinders made in compliance with specifications ICC-4B, ICC-4BA, ICC-26-240[1], or ICC-26-300[1], used exclusively for liquefied petroleum gas which is commercially free from corroding components, may, in lieu of the periodic hydrostatic retest, be given a complete external visual inspection at the time such periodic retest becomes due. When this inspection is used in lieu of hydrostatic retesting, subsequent inspections are required 5 years after the first such inspection and periodically at 5-year intervals hereafter. Inspections shall be made only by competent persons and the results shall be recorded on a suitable data sheet, the completed copies of which shall be kept as a permanent record. The points to be recorded and checked on these data sheets are: Date of inspection (month and year); ICC specification number; cylinder identification (registered symbol and serial number, date of manufacture, and ownership symbol (if needed for adequate identification)); type cylinder protective coating (painted, galvanized, etc., and statement as to need of refinishing or recoating); conditions checked (leakage, corrosion, gouges, dents or digs in shell or heads, broken or damaged footring or protective ring, or fire damage); disposition of cylinders (returned to service, to cylinder manufacturer for repairs, or scrapped); a cylinder which passes the inspection prescribed shall have the date recorded in the manner presently prescribed for the recording of the retest date, except that an "E" is to follow the date (month and year) indicating requalification by the external inspection method.

(13) Cylinders made in compliance with specification ICC-3A480 used exclusively for anhydrous ammonia, commercially free from corroding components, and protected externally by suitable corrosion resisting coatings (such as painting, etc.) may be retested decennially instead of quinquennially. All tests must be supplemented by a very careful examination of the cylinder at each filling, and the cylinder must be rejected if evidence is found of bad dents, corroded areas, a leak or other conditions that indicate possible weakness which would render the cylinder unfit for service.

(l) Repair of specifications ICC-3A, 3AA, 3B, or 3C cylinders by welding or brazing authorized, but only for the removal and replacement of neckrings and footrings attached to cylinders originally manufactured to conform to § 78.36-9 (a). Removal and replacement must be done by a regular manufacturer of this type of cylinder. After removal and before replacement of such parts, cylinders must be inspected, and defective ones rejected. Cylinders, neckrings, footrings, and method of replacement must conform to § 78.36-9 (a). Replacement must be followed by reheat treating, testing, inspection, and supervised and reported as prescribed by the specification covering their original manufacture. Inspector's reports must conform to § 78.36-22 (a) and substitute the word repaired in place of manufactured. Show original markings and the new additional markings added, and statement: "Cylinders were carefully inspected for defects after removal of neckrings and footrings and after replacement, which replacement was made by process of ...."
(Welding-brazing)

(m) Repairs on ICC-4 series, and ICC-8, welded or brazed cylinders are authorized to be made by welding or brazing. Such repairs must be made by a manufacturer of this type of ICC cylinder and by a process similar to that used in its manufacture and under the following specific requirements:

(1) Cylinders with injurious defects in welded joints in or on pressure parts must be repaired by completely removing the defect prior to rewelding.

(2) Cylinders with injurious defects in brazed joints in or on pressure parts must be repaired by rebrazing.

(3) Cylinders during welding must be free of materials in contact with the welded joint that may impair the serviceability of the metal in or adjacent to the weld.

(Precautions must be taken to prevent acetylene cylinder steels from picking up carbon during repair.)

(4) Neckrings, footrings, or other nonpressure attachments authorized by the specification may be replaced or repaired.

(5) After removal, and before replacement of attachments, cylinders must be inspected and defective ones rejected, repaired or rebuilt.

(6) After repair, cylinders must be reheat-treated, tested, inspected and reported when and as prescribed by the specification covering their original manufacture when welding or brazing seams in a pressure part of a cylinder; or when welding or brazing on pressure parts of cylinders of plain carbon steels with carbon over 0.25 percent or manganese over 1.00 percent or of alloy steels.

NOTE 1: Heat-treatment is not required after welding or brazing weldable low carbon parts to attachments of similar material which has been previously welded or brazed to the top or bottom of cylinders and properly heat-treated, provided such subsequent welding or brazing does not produce a temperature in excess of 400°F. in any part of the top or bottom material. The physical and flattening tests may be omitted when the cylinders are not reheat-treated.

(7) Repair of cylinders must be followed by a proof pressure leakage test at prescribed test pressure and visual examination for weld quality when welding or brazing on pressure parts of cylinders of plain carbon steel with carbon 0.25 percent or less and manganese 1.00 percent or less.

(n) Repair of nonpressure attachments by welding or brazing without affecting a pressure part of the cylinder must be followed by visual examination for weld quality.

(o) Walls, heads or bottoms of cylinders with injurious defects or leaks in base metal shall not be repaired, but may be replaced as provided for in paragraph (p) of this section.

(p) Rebuilding of ICC-4 series, and ICC-8, welded or brazed cylinders is authorized. Such rebuilding must be done by a manufacturer of this type of ICC cylinder and by a process similar to that used in its original manufacture and under the following specific requirements:

(1) The replacement of a pressure part such as wall, heads, or bottoms of cylinders or the replacement of the porous filling material, shall be considered as rebuilding.

(2) Rebuilt cylinders shall be considered as new cylinders and shall conform to all the requirements of the specifications applying, including verification of material, examination, inspection, etc., and the rendering of the proper reports to the purchaser, cylinder rebuilder, and the Bureau of Explosives.

(3) Information in sufficient detail regarding previous serial numbers and identification symbols must be filed with the Bureau of Explosives.

(q) A cylinder must be condemned when it leaks, or when internal or external corrosion, denting, bulging, or evidence of rough usage exists to the extent that the cylinder is likely to be weakened appreciably. Condemned cylinders, ICC-4 series, and ICC-8, may be repaired and rebuilt as prescribed in paragraphs (m), (n), (o), and (p), of this section.

SUBPART B — EXPLOSIVES; DEFINITIONS AND PREPARATION

§ 73.50 An explosive. (a) For the purpose of Parts 71-78 an explosive is defined as any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion, i. e., with substantially instantaneous release of gas and heat, unless such compound, mixture, or device is otherwise specifically classified in Parts 71-78.

§ 73.51 Forbidden explosives. (a) The offering of the following explosives for transportation by common carriers by rail freight, rail express, highway, or water is forbidden.

(b) Explosive compositions that ignite spontaneously or undergo marked decomposition when subjected for 48 consecutive hours to a temperature of 75°C. (167°F.).

(c) Explosives containing an ammonium salt and a chlorate.

(d) Liquid nitroglycerin, diethylene glycol dinitrate or other liquid explosives not authorized by § 73.53 (e) and (h) of this part. (For shipment by carrier by motor vehicle other than common carriers, see § 77.822 (b)).

(e) Explosives condemned by the Bureau of Explosives (except properly packed samples for laboratory examinations). Appeal may be made to the Commission from such condemnations.

(f) Leaking or damaged packages of explosives.

(g) Condemned or leaking dynamite must not be repacked and offered for shipment unless the repacking is done by a competent person in the presence of, or with the written consent of, an inspector, or with the written authority of the chief inspector of the Bureau of Explosives.

(h) Firecrackers, flash crackers or salutes, the explosive content of which exceeds 12 grains each in weight, or pest control bombs, the explosive content of which exceeds 18 grains each in weight.

(i) Fireworks that combine an explosive and a detonator or blasting cap.

(j) Fireworks containing an ammonium salt and a chlorate.

(k) Fireworks containing yellow or white phosphorus.

(l) Fireworks or fireworks compositions that ignite spontaneously or undergo marked decomposition when subjected for 48 consecutive hours to a temperature of 75°C. (167°F.).

(m) Fireworks, properly condemned by the Bureau of Explosives, except properly repacked samples for laboratory examinations.

(n) Toy torpedoes, the maximum outside dimension of which exceeds ⅞ inch, or toy torpedoes containing a mixture of potassium chlorate, black antimony and sulfur with an average weight of explosive composition in each torpedo exceeding four grains.

(o) Toy torpedoes containing a cap composed of a mixture of red phosphorus and potassium chlorate exceeding an average of one-half (0.5) grain per cap.

(p) Fireworks containing copper sulfate and a chlorate.

(q) New explosives (except samples for laboratory examination (see § 73.86)), until approved for transportation by the Bureau of Explosives.

(r) Loaded firearms.

§ 73.52 Acceptable explosives. (a) For the purpose of Parts 71-78, acceptable explosives are divided into three classes as defined in this section, viz. (see § 72.5 for restrictions for shipments by rail express).

(1) Class A explosives; detonating or otherwise of maximum hazard.

(2) Class B explosives; flammable hazard.

(3) Class C explosives; minimum hazard.

CLASS A EXPLOSIVES; DEFINITIONS

§ 73.53 Definition of class A explosives. (a) **Type 1.** Solid explosives which can be caused to deflagrate by contact with sparks or flame such as produced by safety fuse or an electric squib, but cannot be detonated (See Note 1) by means of a No. 8 test blasting cap (See Note 2). Example: Black powder and low explosives.

(b) **Type 2.** Solid explosives which contain a liquid ingredient, and which, when unconfined (See Note 3), can be detonated by means of a No. 8 test blasting cap (See Note 2); or which can be exploded in at least 50 percent of the trials in the Bureau of Explosives' Impact Apparatus (See Note 4) under a drop of 4 inches or more, but cannot be exploded in more than 50 percent of the trials under a drop of less than 4 inches. Example: High explosives, commercial dynamite containing a liquid explosive ingredient.

(c) **Type 3.** Solid explosives which contain no liquid explosive ingredient and which can be detonated, when unconfined (See Note 3), by means of a No. 8 test blasting cap (See Note 2); or which can be exploded in at least 50 percent of the trials in the Bureau of Explosives' Impact Apparatus (See Note 4) under a drop of 4 inches or more, but cannot be exploded in more than 50 percent of the trials under a drop of less than 4 inches. Example: High explosives, commercial dynamite containing no liquid explosive ingredient, trinitrotoluene, amatol, tetryl, picric acid, urea nitrate, pentolite, and commercial boosters.

(d) **Type 4.** Solid explosives which can be caused to detonate when unconfined (See Note 3), by contact with sparks or flame such as produced by safety fuse or an electric squib; or which can be exploded in the Bureau of Explosives' Impact Apparatus (See Note 4) in more than 50 percent of the trials under a drop of less than 4 inches. Example: Initiating and priming explosives, lead azide, fulminate of mercury, etc., and high explosives.

(e) Type 5. Desensitized liquid explosives are explosives which may be detonated separately or when absorbed in sterile absorbent cotton, by a No. 8 test blasting cap (See Note 2); but which cannot be exploded in the Bureau of Explosives' Impact Apparatus (See Note 4) by a drop of less than 10 inches. The desensitizer must not be significantly more volatile than nitroglycerin and the desensitized explosive must not freeze at temperatures above minus 10°F. Example: High explosives, desensitized nitroglycerin.

(f) Type 6. Liquid explosives that can be exploded in the Bureau of Explosives' Impact Apparatus (See Note 4) under a drop of less than 10 inches. Example: Nitroglycerin. (See § 73.51 (d) of this part.)

(g) Type 7. Blasting caps (See Note 5) are small tubes, usually made of an alloy of either copper or aluminum, or of molded plastic, closed at one end and loaded with a charge of initiating or priming explosives, class A — Type 4, either with or without other suitable explosives. The total weight of explosives per unit shall not exceed 150 grains. Blasting caps (See Note 5) which have been provided with a means for firing by an electric current, and sealed, are known as electric blasting caps.

(1) Detonating primers are devices for commercial use which contain a detonator and an additional charge of explosives, all assembled in a suitable envelope.

(2) Detonating fuzes, class A, are used in the military service to detonate the high explosive bursting charges of projectiles, mines, bombs, torpedoes, and grenades. In addition to a powerful detonator, they may contain several ounces of a high explosive, such as tetryl or dry nitrocellulose, all assembled in a heavy steel envelope. They may also contain a small amount of radioactive component. Those that are so made and packed that they will not cause functioning of other fuzes, explosives, or explosive devices in the same or adjacent containers are classed as class C explosives.

(h) Type 8. Any solid or liquid compound, mixture or device which is not specifically included in any of the above types, and which under special conditions may be so designated and approved by the Bureau of Explosives. Example: Shaped charges, commercial.

(1) A shaped charge, commercial, consists of a plastic, paper, or other suitable container comprising a charge of not to exceed 8 ounces of a high explosive containing no liquid explosive ingredient and with a hollowed out portion (cavity) lined with a rigid material. This device shall not contain a detonator.

NOTE 1: The detonation test is performed by placing the sample in an open-end fiber tube which is set on the end of a lead block approximately 1½ inches in diameter and 4 inches high which, in turn, is placed on a solid base. A steel plate may be placed between the fiber tube and the lead block.

NOTE 2: A No. 8 test blasting cap is one containing two grams of a mixture of 80 percent mercury fulminate and 20 percent potassium chlorate, or a cap of equivalent strength.

NOTE 3: "Unconfined" as used in this section does not exclude the use of a paper or soft fiber tube wrapping to facilitate tests.

NOTE 4: The Bureau of Explosives Impact Apparatus is a testing device designed so that a guided 8-pound weight may be dropped from predetermined heights so as to impact specific quantities of liquid or solid materials under fixed conditions. Detailed prints may be obtained from the Bureau of Explosives, 30 Vesey Street, New York 7, New York.

NOTE 5: Blasting caps, blasting caps with safety fuse, or electric blasting caps in quantities of 1,000 or less are classified as class C explosives.

(i) Ammunition for cannon. Ammunition for cannon is fixed, semi-fixed or separate loading ammunition which is fired from a cannon, mortar, gun, howitzer or recoilless rifle.

(j) Ammunition for cannon with projectiles. Ammunition for cannon with explosive projectiles, gas projectiles, smoke projectiles, incendiary projectiles, illuminating projectiles, or shell is fixed ammunition assembled in a unit consisting of the cartridge case containing the propelling charge and primer, and the projectiles, or shell, fuzed or unfuzed. Detonating fuzes, tracer fuzes, explosive or ignition devices, or fuze parts with explosives contained therein must not be assembled in ammunition or included in the same outside package unless shipped by, for, or to the Departments of the Army, Navy, and Air Force of the United States Government or unless of a type approved by the Bureau of Explosives.

(k) Explosive projectiles. Explosive projectiles are shells, projectiles, guided missiles with war heads, war heads, or rocket heads, loaded with explosives or bursting charges, with or without other materials, for use in cannons, guns, tubes, mortars or other firing or launching devices.

(l) Grenades. Grenades, hand or rifle, are small metal or other containers designed to be thrown by hand or projected from a rifle. They are filled with an explosive or a liquid, gas or solid material such as a toxic or tear gas or an incendiary or smoke producing material and a bursting charge. When shipped without explosives or bursting charges, see §§ 73.330, 73.350, and 73.383 of this part.

(m) Explosive bombs. Explosive bombs are metal or other containers filled with explosives. They are used in warfare and include aeroplane bombs and depth bombs.

(n) Explosive mines. Explosive mines are metal containers filled with a high explosive.

(o) Explosive torpedoes. Explosive torpedoes, such as are used in warfare, are metal devices containing a means of propulsion and a quantity of high explosives.

(p) Rocket ammunition. Rocket ammunition is fixed ammunition which is fired from a tube, launcher, rails, trough, or other device as dinstinguished from cannon ammunition which is fired from a cannon, gun, or mortar. It consists of an igniter and propelling charge, commonly described as a motor and explosive projectile, gas projectile, smoke projectile, incendiary projectile, or illuminating projectile, fuzed or unfuzed.

(q) Ammunition for small arms with explosive bullets or explosive projectiles. Ammunition for small arms with explosive bullets or ammunition for small arms with explosive projectiles is fixed ammunition to be used in machine guns or similar fire arms and consists of a metallic cartridge case, the primer and the propelling charge, with explosive bullet or explosive projectile with or without detonating fuze, the component parts necessary for one firing being all in one assembly. Detonating fuzes, tracer fuzes, explosive or ignition devices or fuze parts with explosives contained therein must not be assembled in ammunition or included in the same outside package unless shipped by, for, or to the Departments of the Army, Navy, and Air Force of the United States Government or unless of a type approved by the Bureau of Explosives.

(r) Chemical ammunition. Chemical ammunition used in warfare is all kinds of explosive chemical projectiles, shells, bombs, grenades, etc., loaded with toxic, tear, or other gas, smoke or incendiary agent, also such miscellaneous apparatus as cloud-gas cylinders, smoke generators, etc., that may be utilized to project chemicals.

(s) Boosters, bursters and supplementary charges. Boosters and supplementary charges consist of a casing containing a high explosive and are used to increase the intensity of explosion of the detonator of a detonating fuze. Bursters consist of a casing containing a high explosive and are used to rupture a projectile or bomb to permit release of its contents.

(t) Jet thrust units (jato), explosive, (class A), or igniters jet thrust (jato), explosive, (class A). (a) Jet thrust units (jato), explosive, (class A), are metal cylinders containing a mixture of chemicals capable of burning rapidly and producing considerable pressure. Under certain conditions the chemical fuel with which the unit is loaded my explode. Jet thrust units are designed to be ignited by an electric igniter. They are used to assist aeroplanes to take off, to propel large missiles and to drive moving targets for practice firing.

(l) Igniters, jet thrust (jato), explosive, (class A), are devices consisting of an electrically operated or remotely controlled igniting element and a fast-burning composition assembled in a unit for use in igniting the propelling charge of jet thrust units. Under certain conditions the burning composition may explode.

(u) **Charged oil well jet perforating guns.** Charged oil well jet perforating guns are steel tubes or metallic strips into which are inserted shaped charges connected in series by primacord. Shaped charges must be of a type described in subparagraph (h) (1) of this section, except that each shaped charge installed in the steel tube or metallic strip shall contain not over 35 grams of high explosive. Charged oil well jet perforating guns must not be transported with blasting caps, electric blasting caps, or other firing devices affixed to or installed in the guns.

(v) **Type 9.** Propellant explosives, class A, are solid chemicals or solid chemical mixtures which are designed to function by rapid combustion of successive layers, generally with little or no smoke. The combustion is controlled by composition, size, and form of grain. Propellant explosives, class A, include some types of smokeless powder and some types of solid propellant explosives for jet thrust units, rockets, or other devices. Any propellant explosive is class A which detonates in any one out of five trials when tested in the packages in which it is offered for transportation. In conducting the test, one propellant container shall be surrounded by inert loaded containers of the same weight, including one inert container placed on top of the propellant container. The propellant shall be ignited by means of a commercial electric squib placed within 4 inches of the bottom of the container. The presence of a crater and absence of flame shall be considered as evidences of detonation.

§ 73.54 Ammunition for cannon. (a) Ammunition for cannon with explosive projectiles, gas projectiles, smoke projectiles, incendiary projectiles, illuminating projectiles or shell must be well packed and properly secured in strong wooden or metal containers.

(b) Each outside package must be plainly marked "AMMUNITION FOR CANNON WITH EXPLOSIVE PROJECTILES," "AMMUNITION FOR CANNON WITH GAS PROJECTILES" (see § 73.409 (a) (1) of this part for required label), "AMMUNITION FOR CANNON WITH SMOKE PROJECTILES," "AMMUNITION FOR CANNON WITH INCENDIARY PROJECTILES," or "AMMUNITION FOR CANNON WITH ILLUMINATING PROJECTILES," as the case may be.

(c) Ammunition for cannon must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§ 73.55 Ammunition, nonexplosive. (a) Nonexplosive ammunition is devices containing no explosives, or other dangerous article, such as cartridge cases, dummy or drill cartridges; empty, sand-loaded or solid projectiles with or without tracers (containing not in excess of 1 ounce of tracer composition), empty mines, empty bombs, solid projectiles, or empty torpedoes, and is exempt from Parts 71-78. Rotating bands should be protected against deformation by method of packing or loading.

§ 73.56 Ammunition, projectiles, grenades, bombs, mines and torpedoes. (a) Detonating fuzes, tracer fuzes, explosive or ignition devices, bouchons, or fuze parts with explosives contained therein, must not be assembled in explosive projectiles, grenades, explosive bombs, explosive mines, or explosive torpedoes, or included in the same outside package with them unless shipped by, for, or to the Departments of the Army, Navy, and Air Force of the United States Government or unless of a type approved by the Bureau of Explosives.

(b) Explosive projectiles, explosive torpedoes, explosive mines, explosive bombs, or explosive grenades except as provided in paragraph (c) of this section, must be packed and properly secured in strong wooden or metal boxes.

(c) Explosive projectiles, explosive torpedoes, explosive mines or explosive bombs, exceeding 90 pounds in weight, and explosive projectiles of not less than 4½ inches in diameter, may be shipped, without being boxed only by, for, or to the Departments of the Army, Navy, and Air Force of the United States Government when securely blocked and braced in accordance with methods approved by the Bureau of Explosives.

(d) Gas projectiles, smoke projectiles, incendiary projectiles, illuminating projectiles, gas bombs, smoke bombs, incendiary bombs, gas grenades, smoke grenades, and incendiary grenades, containing a bursting charge must be packed and properly secured in strong wooden boxes. Detonating fuzes, bouchons or ignition elements must not be assembled in these articles unless shipped by, for, or to the Departments of the Army, Navy, and Air Force of the United States Government or unless of a type approved by the Bureau of Explosives. (See §§ 73.190, 73.330, 73.350, and 73.383 for nonexplosive chemical or poisonous ammunition.)

(e) The gross weight of a box containing more than one projectile, mine, grenade, or bomb must not exceed 250 pounds.

(f) Each exterior package or projectile, bomb, or mine must be plainly marked "EXPLOSIVE PROJECTILE," "EXPLOSIVE TORPEDO," "EXPLOSIVE MINE," "EXPLOSIVE BOMB," "HAND GRENADES," or "RIFLE GRENADES," as the case may be, except that each device need not be so marked when palletized and the palletized units are plainly marked and shipped as carload or truckload shipments.

(g) Ammunition for cannon with gas projectiles, and bombs, projectiles, grenades or other containers loaded with a poisonous gas or liquid, class A, and an explosive charge, either boxed or unboxed (see paragraph (c) of this section), must bear the white "Poison Gas" label.

(h) For regulations for shipping ammunition containing chemicals but no explosives or bursting charges, see chemical ammunition, §§ 73.330, 73.350, and 73.383 of this part.

(i) Articles described in paragraphs (a), (b), (c), (d) and (g) of this section must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§ 73.57 Rocket ammunition. (a) Rocket ammunition with explosive projectiles, gas projectiles, smoke projectiles, incendiary projectiles, or illuminating projectiles must be well packed and properly secured in strong wooden or metal containers.

(b) Each outside package must be plainly marked "ROCKET AMMUNITION WITH EXPLOSIVE PROJECTILES," "ROCKET AMMUNITION WITH GAS PROJECTILES" (see § 73.402 (a) (6) of this part for required label), "ROCKET AMMUNITION WITH SMOKE PROJECTILES," "ROCKET AMMUNITION WITH INCENDIARY PROJECTILES," or "ROCKET AMMUNITION WITH ILLUMINATING PROJECTILES," as the case may be.

(c) Rocket ammunition must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§ 73.58 Ammunition for small arms. (a) Ammunition for small arms with explosive bullets and ammunition for small arms with explosive projectiles must be well packed and properly secured in strong wooden or metal containers. The gross weight of the outside package must not exceed 150 pounds.

(b) Each outside package must be plainly marked "AMMUNITION FOR SMALL ARMS WITH EXPLOSIVE BULLETS" or "AMMUNITION FOR SMALL ARMS WITH EXPLOSIVE PROJECTILES," as the case may be.

(c) Ammunition for small arms with explosive bullets or ammunition for small arms with explosive projectiles must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§ 73.59 Chemical ammunition, explosive. (a) When chemical elements of ammunition are shipped assembled with their detonating fuzes or bursting charges, they must be shipped in conformity with the regulations prescribed for explosive articles, class A, see § 73.56. For shipment of these articles not containing ignition elements, bursting charges, detonating fuzes, or other explosive components, see §§ 73.330, 73.350, and 73.383. For shipment of these articles assembled with their ignition elements or expelling charges but without any detonating or bursting charge see § 73.88 (d).

(b) Chemical ammunition, explosive must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§ 73.60 **Black powder and low explosives.** (a) Black powder and low explosives must be packed in containers complying with the following specifications:

(1) Spec. 10B. Wooden barrels or kegs. Not over 200 pounds gross weight.

(2) Spec. 13. Metal kegs, not less than 7 inches long. Net weight not less than 6¼ pounds nor more than 150 pounds.

(3) Bundles of metal kegs, spec. 13, firmly tied together with rope and wrapped in strong burlap, canvas, or similar material, securely sewed and roped, authorized. Net weight of powder must not exceed 100 pounds.

(4) Spec. 14, 15A, or 16A. Wooden boxes with inside containers which must be spec. 13, metal kegs, or fiber or metal containers not over 1½ pounds capacity each, or cotton bags of at least 4 ounce cotton duck not over 25 pounds capacity each. The gross weight of spec. 14 boxes not to exceed 140 pounds and the gross weight of spec. 15A or 16A boxes not to exceed 200 pounds.

(5) Spec. 14, 15A, or 16A. Wooden boxes with inside cylindrical fiber cartridges not over 5 inches diameter nor over 18 inches long with fiber at least 0.05 inch thick paraffined on outer surface with joints securely glued or cemented, or strong paraffined paper cartridges not over 12 inches long authorized only for compressed pellets (cylindrical block) ⅞ inch or more in diameter. Boxes must be completely lined with strong paraffined paper or other suitable waterproofed material without joints or other openings at the bottom or sides. Authorized gross weight not to exceed 75 pounds.

(6) Spec. 12H, 23F, or 23H. Fiberboard boxes with inside cylindrical fiber cartridges not over 5 inches diameter nor over 18 inches long with fiber at least 0.05 inch thick paraffined on outer surface with jonits securely glued or cemented, or strong paraffined paper cartridges not over 12 inches long authorized only for compressed pellets (cylindrical block) ⅞ inch or more in diameter. Boxes must be completely lined with strong paraffined paper or other suitable waterproofed material without joints or other openings at the bottom or sides. Authorized gross weight not to exceed 65 pounds.

(b) Black powder (not low explosives) in addition to containers specified in paragraph (a) of this section, must be shipped in containers complying with the following specifications:

(1) Spec. 14, 15A, or 16A. Wooden boxes with inside containers which must be cloth or paper bags of capacity not exceeding 25 pounds net weight, provided the completed shipping package shall be capable of standing a drop of 4 feet without rupture of inner or outer containers. The completed package must not exceed 50 pounds, net weight, of black powder.

(2) Spec. 12H, 23F, or 23H. Fiberboard boxes with inside containers which must be cloth or paper bags of capacity not exceeding 25 pounds, net weight, or inside fiber or metal containers having not over 1 pound capacity each, provided the completed shipping package shall be capable of withstanding a drop of 4 feet without rupture of inner or outer containers. The tubes of the box may be eliminated and a single tube as specified in spec. 23F may be substituted. The completed package shall not contain more than 50 pounds, net weight, of black powder.

(3) Spec. 17E. Metal drums (single-trip), not over 5 gallons capacity each, without opening except bunghole not exceeding 2.3 inches in diameter. Authorized for carload or truckload shipments only.

(c) Black pellet powder primed with an electric squib secured inside the coaxial hole of the pellet powder with loose ends of the wires of the squib effectively short-circuited may be shipped in containers complying with the following specifications:

(1) Spec. 14, 15A, or 16A. Wooden boxes with inside cartridges which must be strong paraffined paper cartridges not over 12 inches long authorized only for compressed pellets (cylindrical block) ⅞ inch or more in diameter. Boxes must be lined as prescribed for cylindrical fiber cartridges. Gross weight not to exceed 65 pounds.

(d) Low explosives (not black powder) may in addition to the containers specified in paragraph (a) of this section, be shipped in containers complying with the following specifications:

(1) Spec. 14, 15A, or 16A. Wooden boxes with inside containers which must be strong paper bags of capacity not exceeding 25 pounds. Gross weight of spec. 14 box must not exceed 140 pounds. Gross weight of spec. 15A or 16A box must not exceed 200 pounds.

(2) Spec. 12H, 23F, or 23H. Fiberboard boxes with inside containers which must be strong paper bags of capacity not exceeding 25 pounds. Gross weight must not exceed 65 pounds.

(3) Spec 15A. Wooden boxes, lined, spec. 2L. Authorized only for low explosives in the form of hard nonplastic rods or cylinders not less than ⅝-inch diameter.

(e) Each outside package must be plainly marked, stamped, or stenciled "BLACK POWDER" or "LOW EXPLOSIVES," and may also show "BLASTING," "RIFLE," etc., as "BLACK BLASTING POWDER," "BLACK RIFLE POWDER," "LOW BLASTING EXPLOSIVE" or "BLACK PELLET POWDER," as the case may be.

(1) Inside containers of over 1½ pounds capacity each in boxes, must be packed with filling holes up, and the boxes must be marked on top "THIS SIDE UP."

(2) Additional marks, trade names, etc., may appear if desired, but such additional marking must not be more conspicuous than nor obscure the marking prescribed herein.

(f) Black powder and low explosives must not be offered for transportation by rail express, except as provided in § 73.86 and §75.675.

§ 73.61 **High explosives.** (a) High explosives (dynamite), except gelatin dynamite, when offered for transportation by rail freight or highway must not contain in excess of 60 percent of liquid explosive ingredient and when offered for transportation by carrier by water must not contain in excess of 75 percent of liquid explosive ingredient. Maximum limit of liquid explosive ingredient specified for transportation by carrier by water applies only for such explosives as consist principally of wood pulp or other satisfactory absorbent and liquid explosive, which are comparable with good commercial dynamite under tests as to leakage of liquid ingredient and sensitiveness to the shocks of transportation, and for shipments that are otherwise in compliance with the regulations in Parts 71-78 for the transportation of high explosives.

(b) High explosives consisting of a liquid mixed with an absorbent material must have the absorbent (wood pulp or similar material) in sufficient quantity and of satisfactory quality, properly dried at the time of mixing; nitrate of soda must be dried at the time of mixing to less than 1 percent of moisture; and the ingredient must be uniformly mixed so that the liquid will remain thoroughly absorbed under the most unfavorable conditions incident to transportation.

(c) High explosives containing nitroglycerin or other liquid explosive ingredients must have uniformly mixed with an absorbent material a satisfactory antacid, which must be in quantity sufficient to have the acid neutralizing power of an amount of magnesium carbonate equal to 1 per cent of the nitroglycerin or other liquid explosive ingredient.

(d) Cartridges shall consist of a column of explosives completely inclosed in shell made of strong paper or polyethylene or a combination of paper and polyethylene, so treated that it will not absorb the liquid ingredient of the explosive.

(e) Bags shall be made of strong paper or equally efficient material so treated or of such nature that it will not absorb the liquid ingredient of the explosive.

(f) All boxes in which high explosives are packed must be lined with strong paraffined paper or other suitable material, except as provided in paragraph (j) of this section, § 73.64 (a) (5), and § 73.65 (a) (5) of this part. Lining must be without joints or other openings or with cemented joints at the bottom, ends, or sides of boxes, and for explosives with liquid ingredients must be impervious to such ingredient and also to water. Covers of boxes must be protected from contact with explosives by lining paper or other suitable material. (See spec. 2L, for authorized lining material.)

(g) Before cartridges or bags of explosives are packed in boxes, lined in accordance with paragraph (f) of this section, dry fine wood pulp or sawdust at least ¼ inch in depth must be spread over the bottom of boxes to be used for all gelatin explosives. Dry fine wood pulp or sawdust must also be used in similar manner for packing all non-gelatinous types of explosives containing 30 percent or more liquid explosive ingredient.

(h) All cartridges exceeding 4 inches in length except gelatin dynamite, or high explosives containing more than 10 percent of a liquid explosive ingredient, must be placed horizontally in boxes. Bags must be packed with their filling holes up.

(i) Movement of cartridges and bags of high explosives within the boxes shall be prevented by sufficiently tight packing.

(j) High explosives (dynamite), except gelatin dynamite, packed in bags or in cartridges in excess of 2 inches in diameter and containing not more than 30 percent liquid explosive ingredients may be packed in outside containers without sawdust and without lining paper provided either each inside or outside container is siftproof and is so treated as to prevent penetration by the commodity with which the container is filled for shipping.

§ 73.62 **High explosives, liquid.** (a) Liquid explosives as defined in § 73.53 (e) must be packed in specification containers as follows:

(1) Spec. 15L. Wooden boxes which must be plainly marked on top and on one side or end "HIGH EXPLOSIVES — DANGEROUS" in letters not less than 7/16 inch in height. The tops of boxes must be marked "THIS SIDE UP."

(2) Spec. 15M. Wooden boxes. Metal inside containers shall contain not more than 10 quarts liquid explosives each. Boxes must be plainly marked on top and on one side or end "HIGH EXPLOSIVES — DANGEROUS" in letters not less than 7/16 inch in height. The tops of boxes must be marked "THIS SIDE UP."

(3) Spec. MC-200. Motor vehicle container.

(b) High explosives, liquid, must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§73.63 **High explosive with liquid explosive ingredient.** (a) High explosives (dynamite) containing not more than 30 percent liquid explosive ingredients must be prepared as prescribed in § 73.61 of this part, except as otherwise specified, and packed in containers complying with the following specifications:

(1) Spec. 23G. Fiberboard boxes. Not more than one cartridge in each box. High explosives packed in boxes consisting of more than one tube joined circumferentially are exempt from the requirements of § 73.61 (f) and (g) of this part. High explosives packed in boxes consisting of one tube closed at the ends are exempt from the requirements of § 73.61 (d), (f), and (g) of this part. Gross weight of boxes not to exceed 65 pounds.

(2) Spec. 14, 15A, or 16A. Wooden boxes, or spec. 12H, 23F, or 23H, fiberboard boxes, with inside containers which must be cartridges not exceeding 12 inches in diameter or 50 pounds in weight with length not to exceed 36 inches, or bags not exceeding 50 pounds each securely closed so as to prevent leakage therefrom. Gross weight of wooden boxes not to exceed 75 pounds and gross weight of fiberboard boxes not to exceed 65 pounds.

(b) High explosives (dynamite) containing 10 percent or less of a liquid explosive ingredient in cartridges or bags as prescribed in § 73.61 (d) and (e) may be packed in wooden boxes, spec. 14, 15A, or 16A, gross weight not to exceed 140 pounds, or fiberboard boxes, spec. 12H, 23F, or 23H, gross weight not to exceed 65 pounds.

(1) High explosives (dynamite) containing 10 percent or less of a liquid explosive ingredient may be packed in fiberboard boxes, spec. 23G. Not more than one cartridge in each box. High explosives packed in boxes consisting of more than one tube joined circumferentially are exempt from the requirements of § 73.61 (f) and (g) of this part. High explosives packed in boxes consisting of one tube closed at the ends are exempt from the requirements of § 73.61 (d), (f), and (g) of this part. Gross weight of boxes not to exceed 65 pounds.

(c) High explosives (dynamite) containing more than 30 percent liquid explosive ingredients must be prepared as prescribed in § 73.61 (a) to (i), inclusive, of this part, except as otherwise specified, and in containers complying with the following specifications:

(1) Spec. 14, 15A, or 16A. Wooden boxes, or spec. 12H, 23F, or 23H, fiberboard boxes with inside containers which must be cartridges not exceeding 4 inches in diameter or 8 inches in length, or cartridges not exceeding 5 inches in diameter or 10 inches in length, provided each such cartridge is enclosed alone, or with other cartridges in another strong paper shell and the resulting cartridge dipped in melted paraffin or equivalent material. The length of such completed cartridge shall not exceed 30 inches. Gross weight of wooden boxes not to exceed 75 pounds and gross weight of fiberboard boxes not to exceed 65 pounds.

(2) Spec. 14, 15A, or 16A. Wooden boxes, or spec. 12H, 23F, or 23H, fiberboard boxes, with inside containers which must be paraffined two-ply paper bags not exceeding 12½ pounds capacity, securely closed by folding the tops and securing the fold by tape, with not more than two such bags inserted into another two-ply paper bag which must be securely closed and dipped in paraffin after closing, or with not more than two inside containers which must be securely closed polyethylene bags not less than 0.004 inches in thickness of not more than 12½ pounds capacity each packed in a securely closed polyethylene or paper bag and packed in polyethylene lined outside fiberboard boxes. Gross weight of wooden boxes not to exceed 75 pounds and gross weight of fiberboard boxes not to exceed 65 pounds.

(d) High explosives (gelatin dynamite and blasting gelatin) must be prepared as prescribed in § 73.61 (a) to (i) inclusive of this part, except as otherwise specified, and in containers complying with the following specifications:

(1) Spec. 23G. Fiberboard boxes. Not more than one cartridge in each box. High explosives packed in boxes consisting of more than one tube joined circumferentially are exempt from the requirements of § 73.61 (f) and (g) or when packed in boxes consisting of one tube closed at the ends are exempt from the requirements of § 73.61 (d) to (g), inclusive. Gross weight of boxes not to exceed 65 pounds.

(2) Spec. 14, 15A, or 16A. Wooden boxes, or spec. 12H, 23F, or 23H, fiberboard boxes, with inside containers which must be cartridges not exceeding 12 inches in diameter or 50 pounds in weight with length not to exceed 36 inches, or bags not exceeding 12½ pounds each. Bags if not completely sealed against leakage by method of closure must be packed with filling holes up. Gross weight of wooden boxes not to exceed 75 pounds and gross weight of fiberboard boxes not to exceed 65 pounds.

(3) High explosives (gelatin dynamite or blasting gelatin) may be shipped in a package consisting of not more than 6 cartridges of such explosives, each not exceeding 32 inches in length or 5 inches in diameter, cartridged with heavy paper in such manner as to have the approximate strength of a spec. 23G container, which cartridges shall in turn be placed in a 10-ply paper tube not exceeding 11 feet in length. The outer paper tube must be equipped with a metal cone or equally efficient device on one end which shall serve to close that end of the tube and to the metal cone shall be affixed a wire threaded through fiber tubes running through the center of each of the 6 cartridges or as alternative to the single wire running through the cartridges in the outer tube at a center, two wires may be applied, one on each side of the cartridges and between the outside of the cartridges and the inside of the outer tube. In either event, cartridges and the outer tube shall be securely closed so as to prevent spilling of any loose explosive under any conditions normally incident to transportation and cartridges shall be so loaded and stayed within the car or motor vehicle as to prevent damage to individual containers. The total gross weight of each completed package shall not exceed 125 pounds. Shipments are authorized in carload or truckload lots only without transfer of packages other than such transfers as may be necessary in the event of mechanical failure of the car or vehicle in which originally loaded.

(e) High explosives (straight gelatin dynamites of 80 per cent strength and over and blasting gelatin) must be packed in cartridges or in bulk in outside boxes. When packed in bulk in boxes double lining paper throughout must be used. Containers must comply with the following specifications:

(1) Spec. 14, 15A, or 16A. Wooden boxes.

(2) Spec. 12H, 23F, 23G, or 23H. Fiberboard boxes. Spec. 23G must be packed in an outer container consisting of at least 7-ply heavy Kraft paper (see § 73.25 for additional required marking.)

(3) Gross weight of wooden boxes not to exceed 75 pounds. Gross weight of fiberboard boxes not to exceed 65 pounds.

(f) Boxes containing high explosives must be plainly marked on top and on one side or end, except those made in compliance with spec. 23G which must be marked on the side or end, and kegs, drums, or barrels containing high explosives must be marked on both ends, "HIGH EXPLOSIVES — DANGEROUS" in letters not less than 7/16 inch in height. The tops of boxes, except those made in compliance with spec. 23G, must be marked "THIS SIDE UP."

(g) High explosives with liquid explosive ingredient must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§ 73.64 High explosives with no liquid explosive ingredient and propellant explosives, class A. (a) High explosives containing no liquid explosive ingredients if their sensitiveness to percussion is not greater than that measured by the blow delivered by an 8-pound weight dropping from a distant of 7 inches on a compressed pellet of the explosive three-hundredths of an inch thick and two-tenths of an inch in diameter, confined rigidly between hard steel surfaces as in the standard Impact Testing Apparatus of the Bureau of Explosives, must be packed in cartridges or in bags in outside boxes. They must be packed in cartridges when their sensitiveness is greater than the limit prescribed herein. Such explosives when dry may be packed in strong sift-proof cloth or paper bags of capacity not exceeding 25 pounds. These explosives must be packed in outside containers complying with the following specifications:

(1) Spec. 14, 15A, or 16A. Wooden boxes.

(2) Spec. 12H, 23F, or 23H. Fiberboard boxes.

(3) Spec. 10B. Wooden barrels or kegs.

(4) Gross weight of wooden boxes not to exceed 140 pounds. Gross weight of fiberboard boxes not to exceed 65 pounds.

(5) When such explosives contain over 5 percent moisture, boxes must be lined with strong paraffined paper or other authorized material, spec. 2L.

(6) When such explosives are in combination cartridges, consisting of column of explosives with core of dynamite, they may be shipped when packed in outside boxes with 65 pounds as the maximum gross weight. The column of explosives must be completely inclosed in waterproofed cloth or strong waterproofed paper and must not exceed 6 inches in diameter, 20 inches in length, or gross weight of 25 pounds.

(7) Spec. 23G. Fiberboard boxes. Such explosives when packed in boxes consisting of more than one tube joined circumferentially are exempt from requirements of § 73.61 (f) and (g) of this part or when packed in boxes consisting of one tube closed at the ends are exempt from requirements of § 73.61 (d) to (g) inclusive, of this part. The gross weight of boxes not to exceed 65 pounds.

b) Boxes containing high explosives must be plainly marked on top and on one side or end, except those made in compliance with spec. 23G which must be marked on the side or end, and kegs, drums, or barrels containing high explosives must be marked on both ends, "HIGH EXPLOSIVES — DANGEROUS" in letters not less than 7/16 inch in height.

(c) High explosives with no liquid explosive ingredient must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

(d) Propellant explosives, class A, must be packed in containers as prescribed in § 73.93. Each outside container must be plainly marked "PROPELLANT EXPLOSIVES, CLASS A."

§ 73.65 High explosives with no liquid explosive ingredient nor any chlorate. (a) High explosives containing no liquid explosive ingredient nor any chlorate if their sensitiveness to percussion is not greater than that measured by the blow delivered by an 8-pound weight dropping from a distance of 7 inches on a compressed pellet of the explosive three-hundredths of an inch thick and two-tenths of an inch in diameter, confined rigidly between hard steel surfaces as in the standard Impact Testing Apparatus of the Bureau of Explosives, must be packed in cartridges, or in bags or metal containers in outside boxes. They must be packed in cartridges when their sensitiveness is greater than the limit prescribed in this section. Such explosives when dry may be packed in strong sift-proof cloth or paper bags or metal containers of capacity not exceeding 25 pounds. These explosives must be packed in outside containers complying with the following specifications:

(1) Spec. 14, 15A, or 16A. Wooden boxes.

NOTE 1: Wooden boxes, having inside metal containers which are tightly and securely closed, may be equipped with hand holes in each end which must be not more than one inch by four inches and centered laterally not nearer than 1⅝ inches from top edge of end of box.

(2) Spec. 12H, 23F, or 23H. Fiberboard boxes.

(3) Spec. 10B. Wooden barrels or kegs.

(4) Gross weight of wooden boxes not to exceed 140 pounds. Gross weight of fiberboard boxes not to exceed 65 pounds.

(5) When such explosives contain over 5 per cent moisture, boxes must be lined with strong paraffined paper or other authorized material, spec. 2L.

(6) When such explosives are in combination cartridges, consisting of column of explosives with core of dynamite, they may be shipped when packed in outside boxes with 65 pounds as the maximum gross weight. The column of explosives must be completely inclosed in waterproofed cloth or strong waterproofed paper and must not exceed 6 inches in diameter, 20 inches in length, or gross weight of 25 pounds.

(7) Spec. 23G. Fiberboard boxes. Such explosives when packed in boxes consisting of more than one tube joined circumferentially are exempt from requirements of § 73.61 (f) and (g) of this part or when packed in boxes consisting of one tube closed at the ends are exempt from requirements of § 73.61 (d) to (g) inclusive, of this part. The gross weight of boxes not to exceed 65 pounds.

(b) Amatol consisting of 80 percent ammonium nitrate and 20 percent trinitrotoluene, ammonium picrate, nitroguanidine, nitrourea, urea nitrate, picric acid, tetryl, trinitroresorcinol, trinitrotoluene, pentolite, cyclotrimethylenetrinitramine (desensitized), and soda amatol, in dry condition, in addition to containers prescribed in paragraphs (a) (1) to (5) of this section, may be shipped in containers complying with the following specifications:

(1) Spec. 14, 15A, or 16A. Wooden boxes with strong paper or cloth bags of capacity not exceeding 50 pounds, packed with filling holes up.

(2) Spec. 21A or 21B. Fiber drums. Net weight not to exceed 200 pounds.

(c) Trinitrotoluene and pentolite, in dry condition, in addition to containers prescribed in paragraphs (a) (1) to (5) and (b) (1) and (2) of this section, may be shipped in specification containers as follows:

(1) Spec. 14, 15A, or 16A. Wooden boxes with strong paper or cloth bags of capacity not exceeding 100 pounds, packed with filling holes up.

(2) Spec. 14, 15A, or 16A. Wooden boxes with strong siftproof liners, spec. 2L.

(d) The following materials may be shipped dry, in quantity not exceeding 4 ounces in one outside package for medicinal purposes or as reagents, by carriers by rail freight, rail express, highway, or water, as drugs, medicines, or chemicals, without other restrictions, when in securely closed bottles or jars properly cushioned to prevent breakage:

(1) Ammonium picrate

(2) Dipicrylamine

(3) Dipicryl sulfide

(4) Dinitrophenylhydrazine

(5) Nitroguanidine

(6) Picramide

(7) Picric acid

(8) Picryl chloride

(9) Trinitroanisole

(10) Trinitrobenzene

(11) Trinitrobenzoic acid

(12) Trinitro-m-cresol

(13) Trinitronaphthalene

(14) Trinitroresorcinol

(15) Trinitrotoluene

(16) Urea nitrate

(e) Ammonium picrate, picric acid, urea nitrate, trinitrobenzene, trinitroresorcinol, trinitrotoluene, cyclotrimethylene-trinitramine, and trinitrobenzoic acid when wet with not less than 10 pounds of water to each 90 pounds of dry material must be shipped in containers complying with the following specifications:

(1) Spec. 10B. Wooden barrels or kegs. Not over 50 gallons nominal capacity.

(2) (See § 73.192 for shipments of wet ammonium picrate, wet picric acid, wet trinitrobenzoic acid, and wet urea nitrate not in excess of 16 ounces and § 73.193 for shipments of wet picric acid, wet trinitrobenzoic acid, and wet urea nitrate not in excess of 25 pounds.) (See § 73.212 for shipments of wet trinitrobenzene and wet trinitrotoluene not in excess of 16 ounces.)

(3) Spec. 5B metal barrels or drums or Spec. 21A or 21B fiber drums. Authorized only for cyclotrimethylenetrinitramine wet with not less than 10 pounds of water to each 90 pounds of dry material in inside containers which must be bags made of at least 10-ounce cotton duck, rubber, or rubberized cloth and securely closed. The dry weight of cyclotrimethylenetrinitramine in one container must not exceed 300 pounds. These bags containing the cyclotrimethylenetrinitramine must then be placed in a rubber bag, rubberized cloth bag or bag made of suitable water-tight material which must be securely closed and then placed in the drum. If shipment of cyclotrimethylenetrinitramine is to take place at a time freezing weather is to be anticipated, it must be wet with a mixture of denatured ethyl alcohol or other suitable anti-freeze and water of such proportions that freezing will not occur in transit.

(f) Amatol when cast in a solid block or column, in addition to containers prescribed in paragraph (a) (1) to (5) of this section, may be shipped in specification containers as follows:

(1) Spec. 13A. Metal drums not exceeding 90 pounds gross weight.

(g) Nitrocellulose must be packed in wooden boxes complying with specs. 14, 15A, or 16A, with inside packages which must be:

(1) Inside packages containing not more than 1 pound each of dry, uncompressed nitrocellulose, wrapped in strong paraffined paper or suitable sparkproof material. Completed outside package not to contain more than 10 pounds dry nitrocellulose.

(2) Inside package containing compressed sticks or blocks of dry nitrocellulose wrapped in strong paraffined paper. Gross weight not to exceed 75 pounds.

(h) Shaped charges, commercial, having exposed lined conical cavities must have such cavities effectively filled; those having conical cavities that are covered shall be paired together with the cavities facing each other and with one or more pairs in a fiber tube, or so arranged that the conical cavities of the shaped charges at the ends of the column face toward the center of the tube. The shaped charges in the fiber tubes must fit snugly with no excess space and the fiber tubes containing the shaped charges must be packed snugly with no excess space in the outside containers. Shaped charges, commercial, must be packed in specification containers as follows:

(1) Spec. 14, 15A, or 16A. Wooden boxes. Gross weight not to exceed 140 pounds.

(2) Spec. 12H, 23F, or 23H. Fiberboard boxes. Gross weight not to exceed 65 pounds.

(3) Spec. 12B. Fiberboard boxes which must be manufactured of at least 275-pound strength (Mullen or Cady test) double-wall corrugated fiberboard and shall be provided with double-faced corrugated lining board (see §78.205-15) having minimum strength (Mullen or Cady test) of 200 pounds. Individual charges of explosives shall be packed in inside securely closed, waterproof plastic containers, or in securely closed waterproof fiberboard containers having metal ends. Gross weight not to exceed 65 pounds. Inside individual containers shall be separated by means of double-faced corrugated fiberboard partitions of material not less than 175-pound Mullen or Cady test.

(i) Boxes containing high explosives must be plainly marked on top and on one side or end, except those made in compliance with spec. 23G which must be marked on the side or end, and kegs, drums, or barrels containing high explosives must be marked on both ends, "HIGH EXPLOSIVES — DANGEROUS" in letters not less than 7/16 inch in height. The tops of boxes, except those referred to in paragraph (a) (1) to (a) (7) of this section, must be marked "THIS SIDE UP."

(k) High explosives with no liquid explosive ingredient nor any chlorate must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§ 73.66 Blasting caps and electric blasting caps. (a) Blasting caps, blasting caps with safety fuse or electric blasting caps in quantity of 1,000 or less are classiffied as class C explosives. See § 73.103 of this part.

(b) The outside of all blasting caps and electric blasting caps must be free from fulminate or other explosive compositions.

(c) Blasting caps containing not to exceed 50 grains of explosive composition each must be placed in strong interior containers, in which they must fit snugly. When caps are loaded vertically in interior metal containers, they must be covered by suitable elastic material placed over the caps. Not more than 100 such blasting caps may be packed in a single container. All inside containers must then be packed snugly in cartons or wrappings made of paper or pasteboard.

(d) Not more than 5,000 blasting caps, not exceeding 50 grains of explosive composition each, packed in inner containers as prescribed in paragraph (c) of this section, must be packed in outside, containers complying with the following specifications:

(1) Spec. 14, 15A, or 16A. Wooden boxes (see § 73.67 (a) (1), Note 1) or spec. 12H, 23F, or 23H, fiberboard boxes, with inside containers which must be cartons or wrappings with inside containers as prescribed in paragraph (c) of this section, which must be separated from the outside box by at least one inch of tightly packed sawdust, excelsior, or equivalent cushioning material. Gross weight not to exceed 150 pounds.

(e) More than 5,000 blasting caps, not exceeding 50 grains of explosive composition each, packed in inner containers as prescribed in paragraph (c) of this section, must be packed in outside containers complying with the following specifications:

(1) Spec. 14, 15A, or 16A. Wooden boxes (see § 73.67 (a) (1), Note 1) or spec. 12H, 23F, or 23H, fiberboard boxes, with inside containers which must be cartons or wrappings with inner containers as prescribed in paragraph (c) of this section, packed in an inside box made of sound lumber, a hermetically sealed metal box of metal not less than 30 gauge United States standard, or a sealed package made of 6 ply Sisalkraft Asphalt Laminated sheeting, or its equivalent; Asphalt Laminated sheeting shall consist of 2 plies of strong fibers, 2 plies of pliable asphalt, and 2 plies of protective cover. The minimum tensile strength shall be 20 pounds per inch width in each direction. The laminated sheet shall have a minimum water resistance of 24 hours and a maximum water permeability of 4 grams per square meter per 24 hours. The inside wooden box, metal box, or sealed package must be separated at all points from the outside box by at least one inch of tightly packed sawdust, excelsior, or equivalent cushioning material. Gross weight not to exceed 150 pounds.

(2) More than 20,000 blasting caps containing not to exceed 50 grains of explosive composition each, must not be placed in one outside package.

(f) Blasting caps containing in excess of 50 grains of explosive composition each must be packed in containers complying with the following specifications:

(1) Spec. 14, 15A, or 16A. Wooden boxes (see § 73.67 (a) (1) (Note 1, of this part) with inside containers which must have strong interior containers, in which they must fit snugly. When caps are loaded vertically in interior metal containers, they must be covered by suitable elastic material placed over the caps. Not more than 10 such blasting caps may be packed in a single inside container. All inside containers must then be packed snugly in cartons or wrappings made of paper or pasteboard. The cartons or wrappings must be separated from outside box by at least 1 inch of tightly packed sawdust, excelsior, or equivalent cushioning material. Not more than 500 caps containing in excess of 50 grains of explosive composition each may be placed in one outside package. Gross weight not to exceed 150 pounds.

(g) Electric blasting caps must be packed in containers complying with the following specifications:

(1) Spec. 14, 15A, or 16A. Wooden boxes (see § 73.67 (a) (1), Note 1) or spec. 12H, 23F, or 23H, fiberboard boxes, with inside containers which must be pasteboard cartons containing not more than 100 caps each, or pasteboard tube inclosing each cap with wires or with the wires wrapped around the tube. Gross weight of wooden boxes containing pasteboard cartons must not exceed 150 pounds, except for export shipment. Gross weight of wooden boxes containing pasteboard tube must not exceed 75 pounds.

(h) Each outside container must be plainly marked "(number) BLASTING CAPS — HANDLE CAREFULLY," or "(number) ELECTRIC BLASTING CAPS — HANDLE CAREFULLY," as the case may be.

NOTE 1: The number of caps must be shown in the marking.

(i) Blasting caps and electric blasting caps must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§ 73.67 **Blasting caps with safety fuse.** (a) Ten or less of the interior containers of not more than 100 blasting caps each, containing not to exceed 50 grains of explosive composition each, packed as prescribed in § 73.66 (c) of this part, in the same outside container with safety fuse must be shipped in containers complying with the following specifications:

(1) Spec. 14, 15A, or 16A. Wooden boxes (see Note 1 of this paragraph) or spec. 12H, 23F or 23H, fiberboard boxes, with inside containers which must be cartons or wrappings with inner containers as prescribed in § 73.66 (c), placed in the center of a coil of fuse and secured and cushioned therein to prevent movement therefrom. Gross weight not to exceed 150 pounds.

NOTE 1: Closing of outside boxes by nailing tops in place with uncoated nails, at not over 3-inch centers into ends, and at not over 6-inch centers into sides, is authorized. Sizes of these nails must be not less than the following:

3-penny into ends and sides not over ⅜ inch thick.
4-penny into ends and sides over ⅜ but not over ½ inch thick.
5-penny into ends and sides over ½ but not over ⅝ inch thick.
6-penny into ends and sides over ⅝ but not over 13/16 inch thick.
7-penny into ends and sides over 13/16 inch thick.

(b) Each outside container must be plainly marked "(number) BLASTING CAPS WITH SAFETY FUSE— HANDLE CAREFULLY."

NOTE 1: The number of caps must be shown in the marking.

(c) Blasting caps with safety fuse must not be offered for transportation by rail express, except as provided in § 73 86 and § 75.675.

§ 73.68 **Detonating primers.** (a) Detonating primers must be packed in containers complying with the following specifications:

(1) Spec. 14, 15A, or 16A. Wooden boxes (see § 73.67 (a) (1), Note 1) or spec. 12H, 23F or 23H, fiberboard boxes, with inside containers which must be pasteboard cartons containing not more than 50 primers each, or pasteboard or plastic tube inclosing each primer with wires, or pasteboard, wooden, metal, or plastic tubes or spools with wires wrapped around the tube or spool. Gross weight of wooden boxes containing pasteboard cartons must not exceed 150 pounds, except for export shipment. Gross weight of wooden boxes containing pasteboard or plastic tube inclosing each primer with wires, or pasteboard, wooden, metal, or plastic tubes or spools with the wires wrapped around the tube or spool must not exceed 75 pounds.

(b) Each outside container must be plainly marked "DETONATING PRIMERS—HANDLE CAREFULLY."

(c) Detonating primers must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§ 73.69 **Detonating fuzes, class A, with or without radioactive components, detonating fuze parts containing an explosive, boosters, bursters, or supplementary charges.** (a) Detonating fuzes, class A with or without radioactive components, detonating fuze parts containing an explosive, boosters, bursters, or supplementary charges, when shipped not assembled in projectiles, bombs, etc., must be packed and well secured in strong tight wooden or metal boxes.

NOTE 1: Radiation on the surface of any detonating fuze, class A, having a radioactive component shall not exceed 100 milliroentgens per hour and the radiation at the surface of the outside shipping container shall not exceed 200 milliroentgens per hour.

(b) The gross weight of one outside package containing detonating fuzes, class A, must not exceed 190 pounds. Boosters, bursters and supplementary charges, without detonators, when shipped separately, must not exceed a gross weight of 300 pounds.

(c) Each outside package must be plainly marked "DETONATING FUZES, CLASS A. EXPLOSIVES— HANDLE CAREFULLY—DO NOT STORE OR LOAD WITH ANY HIGH EXPLOSIVES," or "DETONATING FUZES, CLASS A EXPLOSIVES, RADIOACTIVE — HANDLE CAREFULLY — DO NOT STORE OR LOAD WITH ANY HIGH EXPLOSIVES," or "BOOSTERS (EXPLOSIVE)—HANDLE CAREFULLY," or "BURSTERS (EXPLOSIVE)–HANDLE CAREFULLY," or "SUPPLEMENTARY CHARGES (EXPLOSIVE)—HANDLE CAREFULLY," as the case may be.

(d) Detonating fuzes, class A, boosters, bursters or supplementary charges must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§ 73.70 **Diazodinitrophenol or lead mononitroresorcinate.** (a) The offering of diazodinitrophenol or lead mononitroresorcinate in a dry condition for transportation by common carriers by rail freight, rail express, highway, or water is forbidden, except as a component of manufactured articles such as percussion caps, detonators, blasting caps, and exploders, the transportation of which is authorized in this part.

(b) Diazodinitrophenol or lead mononitroresorcinate must be packed wet with not less than 40 percent by weight of water in specification containers 5 or 5B metal barrels or drums or 10B wooden barrels or kegs, with inside containers which must be bags made of at least 10-ounce cotton duck, rubber, or rubberized cloth, which must be securely closed. The dry weight of diazodinitrophenol in one container must not exceed 220 pounds and the dry weight of lead mononitroresorcinate in one container must not exceed 100 pounds. The bags containing diazodinitrophenol or lead mononitroresorcinate must be placed in a rubber bag, rubberized cloth bag, or bag made of suitable watertight material and then placed in the barrel, keg, or drum. Any empty space in the outside bag must be filled with water and this bag securely closed.

(c) Sufficient outage in outside container must be allowed to prevent rupturing of container in freezing weather, or a mixture of denatured alcohol and water may be used to prevent freezing in transit.

(d) Each barrel, box, drum, or keg must be plainly marked "INITIATING EXPLOSIVE—DANGEROUS— DO NOT STORE OR LOAD WITH ANY HIGH EXPLOSIVE."

(e) Diazodinitrophenol or lead mononitroresorcinate, wet, must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§ 73.71 **Fulminate of mercury.** (a) The offering of fulminate of mercury in a dry condition for transportation by common carriers by rail freight, rail express, highway, or water is forbidden, except as a component of manufactured articles such as percussion caps, detonators, blasting caps, and exploders, the transportation of which is authorized in this part.

(b) Fulminate of mercury must be packed wet with not less than 25 percent by weight of water in specification containers 5 or 5B metal barrels or drums, 17H metal drums (single-trip), or 10B wooden barrels or kegs, with inside container which must be a bag made of 4-ounce duck. Inside the bag and over the fulminate there must be placed a cap of the same fabric, of the same diameter as the bag. The bag must be securely tied and placed in a strong grain bag. This grain bag must also be securely tied. The dry weight of fulminate in one container must not exceed 150 pounds. The bag and contents must be packed in the center of the wooden barrel or keg, metal barrel or drum, and must be entirely surrounded by not less than 3 inches of a well-packed sawdust saturated with water. The wooden barrel or keg, or metal barrel or drum, must be lined with a heavy, close-fitting, jute bag closed by secure sewing to prevent escape of sawdust. The barrel, keg, or drum must be inspected carefully and all leaks stopped.

(c) If shipment of fulminate is to take place at a time that freezing weather is to be anticipated, a mixture of denatured ethyl alcohol and water of such proportions that freezing will not occur in transit must be used.

(d) Each barrel, keg or drum must be plainly marked "INITIATING EXPLOSIVE—DANGEROUS—DO NOT STORE OR LOAD WITH ANY HIGH EXPLOSIVE."

(e) Fulminate of mercury, wet, must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§ 73.72 **Guanyl nitrosamino guanylidene hydrazine.** (a) The offering of guanyl nitrosamino guanylidene hydrazine in a dry condition for transportation by common carriers by rail freight, rail express, highway, or water is forbidden, except as a component of manufactured articles such as percussion caps, detonators, blasting caps, and exploders, the transportation of which is authorized in this part.

(b) Guanyl nitrosamino guanylidene hydrazine must be packed wet with not less than 30 percent by weight of water in specification containers 5 or 5B metal barrels or drums, 17H metal drums (single-trip), or 10B wooden barrels or kegs, with inside container which must be a bag made of 4-ounce duck. Inside the bag and over the guanyl nitrosamino guanylidene hydrazine there must be placed a cap of the same fabric, of the same diameter as the bag. The bag must be securely tied and placed in a strong grain bag. This grain bag must also be securely tied. The dry weight of guanyl nitrosamino guanylidene hydrazine in one container must not exceed 75 pounds. The bag and contents must be packed in the center of the wooden barrel or keg, metal barrel or drum, and must be entirely surrounded by not less than 3 inches of well-packed sawdust saturated with water. The wooden barrel or keg, or metal barrel or drum, must be lined with a heavy, close-fitting, jute bag closed by secure sewing to prevent escape of sawdust. The barrel, keg, or drum must be inspected carefully and all leaks stopped.

(c) If shipment of guanyl nitrosamino guanylidene hydrazine is to take place at a time that freezing weather is to be anticipated, a mixture of denatured ethyl alcohol and water of such proportions that freezing will not occur in transit must be used.

(d) Each barrel, keg, or drum must be plainly marked "INITIATING EXPLOSIVE—DANGEROUS—DO NOT STORE OR LOAD WITH ANY HIGH EXPLOSIVE."

(e) Guanyl nitrosamino guanylidene hydrazine, wet, must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§ 73.73 **Lead azide.** (a) The offering of lead azide in a dry condition for transportation by common carriers by rail freight, rail express, highway, or water is forbidden, except as a component of manufactured articles such as percussion caps, detonators, blasting caps, and exploders, the transportation of which is authorized in this part.

(b) **Lead azide, dextrinated type, or otherwise prepared to effectively control grain size,** must be packed wet with not less than 20 percent by weight of water in specification containers 5 or 5B metal barrels or drums, 17H metal drums (single-trip), or 10B wooden barrels or kegs, with inside container which must be a bag made of 4-ounce duck. Inside the bag and over the lead azide there must be placed a cap of the same fabric, of the same diameter as the bag. The bag must be securely tied and placed in a strong grain bag. This grain bag must also be securely tied. The dry weight of lead azide in one container must not exceed 150 pounds. The bag and contents must be packed in the center of the wooden barrel or keg, metal barrel or drum, and must be entirely surrounded by not less than 3 inches of well-packed sawdust saturated with water. The wooden barrel or keg, or metal barrel or drum, must be lined with a heavy, close-fitting, jute bag closed by secure sewing to prevent escape of sawdust. The barrel, keg, or drum must be inspected carefully and all leaks stopped.

(c) If shipment of lead azide is to take place at a time that freezing weather is to be anticipated, a mixture of denatured ethyl alcohol and water of such proportions that freezing will not occur in transit must be used.

(d) Each barrel, keg, or drum must be plainly marked "INITIATING EXPLOSIVE—DANGEROUS—DO NOT STORE OR LOAD WITH ANY HIGH EXPLOSIVE."

(e) Lead azide, wet, must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§ 73.74 **Lead styphnate.** (a) The offering of lead styphnate (lead trinitroresorcinate) in a dry condition for transportation by common carriers by rail freight, rail express, highway, or water is forbidden, except as a component of manufactured articles such as percussion caps, detonators, blasting caps, and exploders, the transportation of which is authorized in this part.

(b) Lead styphnate (lead trinitroresorcinate) must be packed wet with not less than 20 percent by weight of water in specification containers 5 or 5B metal barrels or drums, 17H metal drums (single-trip), or 10B wooden barrels or kegs, with inside container which must be a bag made of rubber cloth. The lead styphnate within this bag should be divided into a number of smaller packages. There must be a cap of the same fabric and of the same diameter as the bag over the lead styphnate and inside the bag. The dry weight of lead styphnate in one outer container must not exceed 150 pounds. The bag and contents must be packed in the center of the wooden barrel or keg, metal barrel or drum, and must be entirely surrounded by not less than 3 inches of well-packed sawdust saturated with water. The wooden barrel or keg, or metal barrel or drum, must be lined with a heavy, close-fitting, jute bag closed by secure sewing to prevent escape of sawdust. The barrel, keg, or drum must be inspected carefully and all leaks stopped.

(c) If shipment of lead styphnate is to take place at a time freezing weather is to be anticipated, it must be wet with a mixture of denatured ethyl alcohol and water of such proportions that freezing will not occur in transit.

(d) Each barrel, keg, or drum must be plainly marked "INITIATING EXPLOSIVE—DANGEROUS—DO NOT STORE OR LOAD WITH ANY HIGH EXPLOSIVE."

(e) Lead styphnate (lead trinitroresorcinate), wet, must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§ 73.75 **Nitro mannite.** (a) The offering of nitro mannite in a dry condition for transportation by common carriers by rail freight, rail express, highway, or water, is forbidden, except as a component of manufactured articles such as percussion caps, detonators, blasting caps, and exploders, the transportation of which is authorized in this part.

(b) Nitro mannite must be packed wet with not less than 40 percent by weight of water in specification containers 5 or 5B metal barrels or drums, or 10B wooden barrels or kegs, with inside containers which must be bags made of at least 10-ounce cotton duck, rubber or rubberized cloth, which must be securely closed. The dry weight of nitro mannite in one container must not exceed 100 pounds. These bags containing the nitro mannite must then be placed in a rubber bag, rubberized cloth bag or bag made of suitable watertight material and then placed in the barrel, keg, or drum. Any empty space in the outside bag must be filled with water and this bag securely closed.

(c) Sufficient outage in outside container must be allowed to prevent rupturing of container in freezing weather, or a mixture of denatured ethyl alcohol and water may be used to prevent freezing in transit.

(d) Each barrel, keg, or drum must be plainly marked "INITIATING EXPLOSIVE—DANGEROUS—DO NOT STORE OR LOAD WITH ANY HIGH EXPLOSIVE."

(e) Nitro mannite, wet, must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§ **73.76 Nitrosoguanidine.** (a) The offering of nitrosoguanidine in a dry condition for transportation by common carriers by rail freight, rail express, highway, or water is forbidden, except as a component of manufactured articles such as percussion caps, deonators, blasting caps, and exploders, the transportation of which is outhorized in this part.

(b) Nitrosoguanidine must be packed wet with not less than 10 percent by weight of water in specification containers 5 or 5B metal barrels or drums, 17H metal drums (single-trip), or 10B wooden barrels or kegs, with inside container which must be a bag made of strong cloth, which must in turn be placed in the wooden barrel, or keg, or metal barrel or drum. The dry weight of nitrosoguanidine in one container must not exceed 75 pounds.

(c) Each barrel, keg, or drum must be plainly marked "INITIATING EXPLOSIVE—DANGEROUS—DO NOT STORE OR LOAD WITH ANY HIGH EXPLOSIVE."

(d) Nitrosoguanidine, wet, must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§ **73.77 Pentaerythrite tetranitrate.** (a) The offering of pentaerythrite tetranitrate in a dry condition for transportation by common carriers by rail freight, rail express, highway or water is forbidden, except as a component of manufactured articles such as percussion caps, detonators, blasting caps, and exploders, the transportation of which is authorized in this part.

(b) Pentaerythrite tetranitrate must be packed wet with not less than 40 percent by weight of water in specification containers 5 or 5B metal barrels or drums, 17H metal drums (single-trip), or 10B wooden barrels or kegs, with inside containers which must be bags made of at least 10-ounce cotton duck, rubber, or rubberized cloth, which must be securely closed. The dry weight of pentaerythrite tetranitrate in one container must not exceed 300 pounds. These bags containing the pentaerythrite tetranitrate must then be placed in a rubber bag, rubberized cloth bag, or bag made of suitable watertight material and then placed in the barrel, keg, or drum. Any empty space in the outside bag must be filled with water and this bag securely closed.

(c) Sufficient outage in outside container must be allowed to prevent rupturing of container in freezing weather, or a mixture of denatured ethyl alcohol or other suitable anti-freeze and water may be used to prevent freezing in transit.

(d) Each barrel, keg, or drum must be plainly marked "INITIATING EXPLOSIVE—DANGEROUS—DO NOT STORE OR LOAD WITH ANY HIGH EXPLOSIVE."

(e) Pentaerythrite tetranitrate, wet, must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§ **73.78 Tetrazene.** (a) The offering of tetrazene (guanyl nitrosamino guanyl tetrazene) in a dry condition for transportation by common carriers by rail freight, rail express, highway, or water is forbidden, except as a component of manufactured articles such as percussion caps, detonators, blasting caps, and exploders, the transportation of which is authorized in this part.

(b) Tetrazene (guanyl nitrosamino guanyl tetrazene) must be packed wet with not less than 30 percent by weight of water in specification containers 5 or 5B metal barrels or drums, 17H metal drums (single-trip), or 10B wooden barrels or kegs, with inside container which must be a bag made of 4-ounce duck. Inside the bag and over the tetrazene there must be placed a cap of the same fabric of the same diameter as the bag. The bag must be securely tied and placed in a strong bag. This grain bag must also be securely tied. The dry weight of the tetrazene in one container must not exceed 75 pounds. The bag and contents must be packed in the center of the wooden barrel or keg, metal barrel or drum, and must be entirely surrounded by not less than 3 inches of well-packed sawdust saturated with water. The wooden barrel or keg, or metal barrel or drum, must be lined with a heavy, close-fitting, jute bag closed by secure sewing to prevent escape of sawdust. The barrel, keg, or drum must be inspected carefully and all leaks stopped.

(c) If the shipment of tetrazene is to take place at a time that freezing weather is to be anticipated, it must be wet with a mixture of denatured ethyl alcohol and water of such proportions that freezing will not occur in transit.

(d) Each barrel, keg, or drum must be plainly marked "INITIATING EXPLOSIVE—DANGEROUS—DO NOT STORE OR LOAD WITH ANY HIGH EXPLOSIVE."

(e) Tetrazene (guanyl nitrosamino guanyl tetrazene), wet, must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§ **73.79 Jet thrust units (jato), explosive, class A or igniters jet thrust (jato), explosive, class A.** (a) Jet thrust units (jato), explosive, must not be shipped with igniters assembled therein unless shipped by, for, or to the Departments of the Army, Navy, and Air Force of the United States Government. Jet thrust units (jato) or igniters jet thrust (jato) must be packed in outside containers complying with the following specifications:

(1) Spec. 14, 15A, 15E, or 16A wooden boxes or wooden boxes, fiberboard lined.

(b) Jet thrust units (jato), class A, or igniters jet thrust (jato), class A, packed in any other manner must be in containers of a type approved by the Bureau of Explosives.

(c) Each outside package must be plainly marked "JET THRUST UNITS, CLASS A EXPLOSIVES" or "IGNITERS, JET THRUST, CLASS A EXPLOSIVES."

(d) Jet thrust units, class A, or igniters, jet thrust, class A, must not be offered for transportation by rail express, except as provided in § 73.86 or § 75.675.

§ **73.80 Charged oil well jet perforating guns.** (a) Charged oil well jet perforating guns, when transported by motor vehicles operated by private carriers engaged in oil well operations in which the total weight of the explosive contents of shaped charges assembled to guns being transported does not exceed 15 pounds per such vehicle are classed as class C explosives. See § 73.110.

(b) Charged oil well jet perforating guns of the steel tube type must be packed without blasting caps, electric blasting caps, or other firing devices affixed to or installed in the guns and transported in fully-enclosed specially-constructed bodies of motor vehicles operated by private carriers engaged in oil well operations. Shaped charges assembled in the steel tubes and connected in series by primacord must be of the same type described in § 73.53 (h) (l), except that each shaped charge shall contain not over 35 grams of high explosive and each shaped charge if not completely enclosed in glass must be fully protected by a metal or other equally efficient cover after installation in the gun.

(c) Charged oil well jet perforating guns of the metallic strip type must be packed without blasting caps, electric blasting caps, or other firing devices affixed to or installed in the guns in steel tubes or pipes having wall thickness at least ¼ inch and of sufficient length and diameter to completely enclose each gun and transported in fully-enclosed specially-constructed bodies of motor vehicles operated by private carriers engaged in oil well operations. Shaped charges assembled in the metallic strips and connected in series by primacord must be of the type described in § 73.53 (h) (l), except that each shaped charge shall contain not over 35 grams of high explosive and each shaped charge if not completely enclosed in glass must be fully protected by a metal or other equally efficient cover after installation in the gun.

(d) The charged oil well jet perforating guns described in paragraphs (b) and (c) of this section and the bodies of motor vehicles transporting such guns must be so designed and constructed that accidental damage to guns or shaped charges will be avoided. The assembled gun or guns packed as required by paragraphs (b) or (c) of this section must be secured in the body of the motor vehicle in a fixed position so as to prevent movement relative to each other or in the body of the motor vehicle.

(e) Blasting caps, electric blasting caps, or other firing devices transported on any motor vehicle operated by private carriers engaged in oil well operations transporting charged oil well jet perforating guns shall be segregated; each kind from every other kind, and from jet perforating guns, tools or other supplies. Blasting caps, electric blasting caps, or other firing devices shall be carried in a container having individual pockets for each such device or by at least equally safe means. No greater number of blasting caps, electric blasting caps, or other firing devices shall be transported on the same motor vehicle transporting oil well jet perforating guns than is necessary for use on any particular trip.

(f) Charged oil well jet perforating guns must not be offered for transportation by carriers by rail freight, rail express, rail baggage, water, or by common or contract carriers by public highway.

§ **73.86 Samples of explosives and explosive articles.** (a) New explosives, including fireworks and explosive devices, other than Army, Navy or Air Corps explosive or chemical ammunition of a security classification, must be examined and approved by the Bureau of Explosives as safe for transportation before being offered for shipment, except that a sample of such explosives, fireworks and explosive devices, not to exceed 5 pounds net weight, may be offered for transportation by carriers by rail freight, highway, or water for this examination. Samples of explosives, except liquid nitroglycerin, other than new explosives for laboratory examination not exceeding 5 pounds net weight may be offered for transportation by carriers by rail freight, highway, or water. For the purpose of Parts 71-78 a new explosive, including fireworks and explosive devices, is the product of a new factory or an explosive or explosive device of an essentially new composition or character made by any factory.

(b) Before being offered for shipment, explosive articles in the experimental state must be made safe by removal of ignition elements or otherwise.

(c) Shipments of samples of explosives, fireworks and explosive devices must be packed, marked, and described as required by this part for the explosive contained therein.

(d) **Samples of explosives and explosive articles for transportation by rail freight, rail express, or highway.** Samples of explosives (except liquid nitroglycerin), including fireworks and explosive devices for examination in a laboratory only and not intended for use or demonstration, may be offered for transportation by rail freight, rail express, or highway provided they fulfill the following requirements:

(1) Samples of explosives including fireworks and explosive devices for laboratory examination must be packed in well-secured metal cans or glass bottles, or in strong waterproof paper or cardboard packages; each sample must consist of not more than one-half pound of explosive, and the interior package must be placed in sawdust or similar cushioning material, at least 2 inches thick, in a wooden box, spec. 14 or 15A.

(2) Whenever these samples of explosives for laboratory examination are contained in a metal envelope or receptacle, this receptacle must be properly cushioned with sawdust or similar cushioning material in a strong wooden box, and this interior box must be packed in a wooden box, spec. 14 or 15A, with at least 2 inches of cushioning material separating the boxes.

(3) Not more than 100 blasting caps may be shipped in one outside package for laboratory examination, and they must be packed and cushioned as provided in paragraph (d) (2) of this section.

(4) Not more than 20 half-pound samples of explosives for laboratory examination may be packed in one outside package or transported in a single car or vehicle at one time.

(5) The net weight of the explosive contents must be plainly marked by the shipper on the otuside of each box offered for transportation.

(6) **Label.** Each outside package containing samples of explosives for laboratory examination must have securely and conspicuously attached to it a square red label as described in § 73.411 of this part.

73.87 Explosives in mixed packing. (a) Unless specifically authorized by Parts 71-78, explosives must not be packed in the same outside package with each other or with other articles. Explosives, except blasting caps and other initiating explosives, in separate interior containers, may be shipped when packed in the same outside package of gross weight not exceeding 50 pounds, provided the weight of any interior package of explosives does not exceed 8 ounces, and provided the interior packages are so cushioned and protected as to insure their transportation without rupture or leakage of contents. The package must be marked and described with the name of the most dangerous explosive included such as "HIGH EXPLOSIVE," or "BLACK POWDER."

CLASS B EXPLOSIVES; DEFINITION

§ **73.88 Definition of class B explosives.** (a) Explosives, class B, are defined as those explosives which in general function by rapid combustion rather than detonation and include some explosive devices such as special fireworks, flash powders, some pyrotechnic signal devices and solid propellant explosives which include some smokeless powders. These explosives are further specifically described in paragraphs (b) to (f) of this section.

(b) **Ammunition for cannon with empty projectiles, inertloaded projectiles, solid projectiles or without projectiles, or shell, and catapult charges exceeding 2 inches in** diameter, is fixed ammunition assembled in a unit consisting of the cartridge case containing the propelling charge and primer with empty, inert-loaded, or solid projectiles, or without projectiles, which is fired from a cannon, mortar, gun, howitzer or recoilless rifle.

(c) Rocket ammunition is fixed ammunition which is fired from a tube, launcher, rails, trough, or other device as distinguished from cannon ammunition which is fired from a cannon, gun, or mortar. It consists of an igniter and propelling charge, commonly described as a motor, and empty projectile, inert-loaded projectile or solid projectile, or without projectile.

(d) **Special fireworks** are manufactured articles designed primarily for the purpose of producing visible or audible pyrotechnic effects by combustion or explosion. (See § 73.100 (r) for common fireworks.) Examples are toy torpedoes, railway torpedoes, some firecrackers and salutes, exhibition display pieces, aeroplane flares, illuminating projectiles, incendiary projectiles or incendiary bombs and smoke projectiles or smoke bombs fuzed or unfuzed and containing expelling charges but without bursting charges, hand or rifle grenades with ignition elements but not containing bursting charges, flash powders in inner units not exceeding 2 ounces each, flash sheets in interior packages, flash powder or spreader cartridges containing not over 72 grains of flash powder each (see § 73.60 for shipments made as low explosives) and flash cartridges consisting of a paper cartridge shell, small-arms primer, and flash composition, not exceeding 180 grains all essembled in one piece. Fireworks must be in a finished state, exclusive of mere ornamentation, as supplied to the retail trade and must be so constructed and packed that loose pyrotechnic composition will not be present in packages in transportation.

(e) Jet thrust units (jato), class B, are metal cylinders containing a mixture of chemicals capable of burning rapidly and producing considerable pressure. Jet thrust units are designed to be ignited by an electric igniter. They are used to assist aeroplanes to take off, to propel large missiles, and to drive moving targets for practice firing.

(1) Igniters, jet thrust (jato), class B, are devices consisting of an electrically operated or remotely controlled igniting element and a fast-burning composition assembled in a unit for use in igniting the propelling charge of jet thrust units.

(2) Starter cartridges, jet engine, consist of plastic and/or rubber cases, each containing a pressed cylindrical block of propellant explosive and having in the top of the case a small plastic compartment that encloses an electric squib, small amounts of black powder, and smokeless powder, which constitute an igniter. The starter cartridge is used to activate a mechanical starter for jet engines.

(f) **Propellant explosives, class B.** Propellant explosives, class B, are solid chemicals or solid chemical mixtures which function by rapid combustion of successive layers, generally with little or no smoke. The combustion is controlled by composition, size, and form of grain. Any propellant explosive is class B which fails to detonate in five trials when tested (See Note 2) in the packages in which it is offered for shipment. Propellant explosives, class B, include smokeless powder for small arms, smokeless powder for cannon, smokeless powder or solid propellant explosives for rockets, jet thrust units, or other devices. Black powder is not included in this classification and is defined specifically in § 73.53 (a).

NOTE 1: Fire-extinguisher charges containing not to exceed 50 grains of propellant explosives per unit are exempt from the regulations in Parts 71-78.

NOTE 2: In conducting the test, one propellant container shall be surrounded by inert loaded containers of the same weight, including one inert container placed on top of the propellant container. The propellant shall be ignited by means of a commercial electric squib placed within 4 inches of the bottom of the container. The presence of a crater and absence of flame shall be considered as evidences of detonation.

§ 73.89 Ammunition for cannon with empty projectiles, inert-loaded projectiles, solid projectiles, or without projectiles or shell. (a) Ammunition for cannon with empty projectiles, inert-loaded projectiles, solid projectiles, or without projectiles or shell, must be well packed and properly secured in strong wooden or metal containers.

(b) Each outside package must be plainly marked "AMMUNITION FOR CANNON WITH EMPTY PROJECTILES," "AMMUNITION FOR CANNON WITH INERT-LOADED PROJECTILES," "AMMUNITION FOR CANNON WITH SOLID PROJECTILES," or "AMMUNITION FOR CANNON WITHOUT PROJECTILES," as the case may be.

(c) Ammunition for cannon with empty projectiles, inert-loaded projectiles, solid projectiles, or without projectiles or shell, must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§ 73.90 Rocket ammunition with empty projectiles, inert-loaded or solid projectiles or without projectiles. (a) Rocket ammunition with empty projectiles, inert-loaded or solid projectiles or without projectiles must be well packed and properly secured in strong wooden or metal containers.

(b) Each outside package must be plainly marked "ROCKET AMMUNITION WITH EMPTY PROJECTILES," "ROCKET AMMUNITION WITH INERT-LOADED PROJECTILES," "ROCKET AMMUNITION WITH SOLID PROJECTILES," or "ROCKET AMMUNITION WITHOUT PROJECTILES," as the case may be.

(c) Articles as defined in § 73.88 (c) of this part must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§ 73.91 Special fireworks. (a) Special fireworks, except as otherwise authorized, must be securely packed in containers complying with the following specifications:

(1) Spec. 11B. Strong, tight, sparkproof wooden barrels.

(2) Spec. 15A, 15B, 16A, or 19A. Wooden boxes. Gross weight not to exceed 500 pounds.

(3) Spec. 12B. Fiberboard boxes. Gross weight not to exceed 65 pounds except as provided in paragraph (a) (5) of this section. Not permitted for illuminating projectiles and aeroplane flares.

(4) Fireworks that can be exploded en masse, by dropping the completed shipping container from a height of six feet or by the impact of a rifle bullet, if found safe for transportation, may be shipped in accordance with the regulations in this part applying to high explosives.

(5) Ship distress signals when packed in tight inside metal containers of not less than 24 gauge sheet iron or other metal of equal strength, securely closed by positive means (not friction) and of such design and so arranged as to completely fill the outside container, may be packed in spec. 12B fiberboard boxes. Gross weight not to exceed 95 pounds when boxes are made in accordance with § 78.205-29.

(b) **Flash or spreader cartridges** not exceeding 72 grains of flash powder each must be packed in containers complying with the following specifications:

(1) Spec. 15A, 15B, 16A, or 19A. Wooden boxes, or spec. 12B fiberboard boxes, with inside containers which must be cartons or tin cans containing not over 6 cartridges and not to exceed 150 cartons or cans to an outer box.

(c) **Flash cartridges** consisting of a paper cartridge shell, small arms primer, and flash composition, not exceeding 180 grains each, all assembled in one piece ready for firing must be packed in containers complying with the following specifications:

(1) Spec. 15A, 15B, 16A, or 19A. Wooden boxes, or spec. 12B fiberboard boxes, with inside containers which must be cartons containing not to exceed 12 cartridges each and not more than 12 such cartons in one outside box.

(2) Flash cartridges, in quantity not exceeding 5 pounds, when in small interior wooden boxes, may be packed with nonexplosive, nonflammable, or noncorrosive articles.

(d) Flash sheets must be packed in containers complying with the following specifications:

(1) Spec. 15A, 15B, 16A or 19A. Wooden boxes, or spec. 12B fiberboard boxes, with inside containers which must be an inner package or envelope containing not more than 6 flash sheets and not more than one dozen inner envelopes or packages inclosed in each inner pasteboard box or carton. Gross weight of wooden box not to exceed 150 pounds. Gross weight of fiberboard box not to exceed 65 pounds.

(2) Flash sheets, in quantity not exceeding 5 pounds, when in small interior wooden boxes, may be packed with nonexplosive, nonflammable, or noncorrosive articles.

(e) **Photographic flash powder** must be packed in containers complying with the following specifications:

(1) Spec. 15A, 15B, 16A, or 19A. Wooden boxes, or spec. 12B fiberboard boxes, with inside containers which must be any inside container sufficiently strong to retain contents not exceeding 2 ounces each. If bottles are used, each bottle must be packed in a securely closed fiber mailing tube having metal ends. Not more than 4 dozen 2-ounce bottles may be packed in an outer wooden box. When packed in units not exceeding 1 ounce each without bottles in similar fiber mailing tubes and outer wooden boxes, the gross weight of one outside box must not exceed 150 pounds. Gross weight of fiberboard box not to exceed 65 pounds.

(2) Photographic flash powder, in quantity not exceeding 5 pounds, when in small interior wooden boxes, may be packed with nonexplosive, nonflammable, or noncorrosive articles.

(f) **Railway torpedoes (track torpedoes)** must be packed in containers complying with the following specifications:

(1) Spec. 15A, 15B, 16A, 19A, or 19B. Wooden boxes. Net weight not to exceed 125 pounds.

(2) Spec. 12H, 23F, or 23H. Fiberboard boxes. Gross weight not to exceed 65 pounds.

(3) Spec. 12B. Fiberboard boxes, with inside containers which must be cartons containing not to exceed one-half gross track torpedoes each. Gross weight of outside fiberboard box not to exceed 65 pounds.

(4) Spec. 12B. Fiberboard boxes without inside containers may be used for not more than 50 track torpedoes provided the smallest dimension of the box is not less than 6 inches.

(g) Toy torpedoes must be securely packed as prescribed in this section in containers complying with the following specifications:

(1) Spec. 15A, 15B, 16A, or 19A wooden boxes, or spec. 12B fiberboard boxes which must be constructed to comply with § 78.205-30. Not more than 20 one-quarter gross cartons totalling not more than 5 gross of toy torpedoes are authorized per fiberboard box. Gross weight of fiberboard box must not exceed 35 pounds. Gross weight of wooden box must not exceed 65 pounds.

(2) Toy torpedoes of any kind must not be packed with other fireworks.

(3) Toy torpedoes containing a cap must be packed in sawdust, in inside paper or cardboard cartons. The size of the carton must be not less than 4 cubic inches for each grain of explosive.

(4) Toy torpedoes containing a mixture of potassium chlorate, black antimony and sulfur, must be packed in an inner container, containing not more than one-fourth gross. The capacity of this inner container must be not less than 105 cubic inches, and it must be divided into 12 equal compartments. All vacant space inside the container must then be filled with sawdust or fine shavings.

(5) The gross weight of a container of toy torpedoes must not exceed 65 pounds.

(h) Except as otherwise specified in this section the gross weight of one outside container of special fireworks must not exceed 500 pounds.

(i) **Marking.** Each outside container of special fireworks must be plainly marked in letters not less than 7/16 inch in height "SPECIAL FIREWORKS—HANDLE CAREFULLY—KEEP FIRE AWAY," except that each outside container of railway torpedoes must be plainly marked in letters not less than 7/16 inch in height. "RAILWAY TORPEDOES–HANDLE CAREFULLY—KEEP FIRE AWAY."

(1) Outside containers of toy torpedoes must in addition be marked "TOY TORPEDOES."

(j) **Label.** Each outside container of special fireworks when offered for transportation by carriers by rail express or water must have securely and conspicuously attached to it a square red label as described in § 73.410 of this part.

§ 73.92 Jet thrust units (jato), class B, igniters, jet thrust (jato), class B, or starter cartridges, jet engine, class B. (a) Jet thrust units (jato), class B, must not be shipped with igniters assembled therein unless shipped by, for, or to the Departments of the Army, Navy, and Air Force of the United States Government. Jet thrust units (jato), class B, igniters, jet thrust (jato), class B, or starter cartridges, jet engine, class B, must be packed in outside containers complying with the following specifications:

(1) Spec. 14, 15A, or 15E, or 16 A, wooden boxes or wooden boxes, fiberboard lined.

(2) Spec. 15B, wooden boxes. Authorized only for igniters, jet thrust (jato), class B.

(3) Spec. 23F. Fiberboard boxes. Authorized for igniters, jet thrust (jato), class B, or starter cartridges, jet engine, class B, only, which must be packed in tightly closed inside fiberboard boxes, at least 200-pound test (Mullen or Cady), or metal containers. Starter cartridges, jet engine, must have igniter wires short-cirtuited when packed for shipment.

(4) Jet thrust units (jato), class B, may be packed in the same outside shipping container with separately packaged igniters, jet thrust, when the containers are approved by the Bureau of Explosives.

(b) Jet thrust units (jato), class B or igniters, jet thrust, (jato) class B, packed in any other manner must be in containers of a type approved by the Bureau of Explosives.

(c) Each outside package must be plainly marked "JET THRUST UNITS, CLASS B EXPLOSIVES," "IGNITERS, JET THRUST, CLASS B EXPLOSIVES," or "STARTER CARTRIDGES, JET ENGINE, CLASS B EXPLOSIVES."

(d) Jet thrust units must not be offered for transportation by rail express, except as provided in § 73.86 and § 75.675.

§ 73.93 **Propellant explosives for cannon, small arms, rockets, guided missiles, or other devices.** (a) Propellant explosives for cannon, small arms, rockets, guided missiles, or other devices, when offered for transportation by carriers by rail freight, highway, or water must be packed in containers complying with the following specifications (see paragraph (f) (1) and (f) (2) of this section and § 75.675 for shipments by rail express):

(1) Spec. 10B. Wooden barrels or kegs. Gross weight not to exceed 200 pounds.

(2) Spec. 13. Metal kegs at least 8 inches long. Gross weight not to exceed 150 pounds.

(3) Bundles of metal kegs, spec. 13, firmly tied together with rope and wrapped in strong burlap, canvas, or similar material, securely sewed and roped, are authorized. Net weight of propellant explosives must not exceed 100 pounds.

(4) Tight metal cases in tight wooden boxes free from loose knots and cracks or tight metal containers. Gross weight not to exceed 200 pounds.

(5) Spec. 14 or 15A. Wooden boxes, metal-lined, spec. 2F. Gross weight not to exceed 200 pounds.

(6) Spec. 14 or 15A wooden boxes, or spec. 23F or 23H fiberboard boxes, with inside containers which must be cloth or paper bags, of capacity not exceeding 25 pounds, net weight, each capable of withstanding, when filled to shipping content, at least two drops on end from a height of 4 feet, without breakage or sifting of contents. Outside container not to exceed more than 50 pounds, net weight.

(7) Spec. 14, 15A, 15B, or 15C wooden boxes, or spec. 23F or 23H, fiberboard boxes, with inside containers which must be spec. 13, metal kegs. Gross weight not to exceed 200 pounds in wooden boxes or 65 pounds in fiberboard boxes.

(8) Spec. 14, 15A, 15B or 15C wooden boxes, or spec. 23F or 23H, fiberboard boxes, with inside containers which must be fiber or metal containers of not more than 1½ pounds capacity each. Gross weight not to exceed 200 pounds in wooden boxes or 65 pounds in fiberboard boxes.

(9) Spec. 14, 15A, 15B or 15C wooden boxes, or spec. 23F or 23H, fiberboard boxes, with inside containers which must be not to exceed four metal containers, spec. 2A, of not more than 25 pounds each. Gross weight in fiberboard boxes not to exceed 65 pounds.

(10) Spec. 21A or 21B. Fiber drums. Drums having wooden heads must be provided with a strong sift-proof liner. Use of these containers will be permitted because of the present emergency and until further order of the Commission.

(11) Spec. 14, 15A, or 16A. Wooden boxes, not lined, authorized only for grains not less than 1-inch in diameter or 3 inches in length, provided such grains are tightly packed and are coated with a protective material. Gross weight not to exceed 200 pounds.

(12) Propellant explosives packed in any manner other than as specifically provided for in this paragraph must be in containers approved by the Bureau of Explosives.

(b) **Propellant explosives (smokeless powder for cannon or small-arms) in water** when offered for transportation by carriers by rail freight, highway, or water must be packed in containers complying with the following specifications:

(1) Spec. 5, 5A, 5B, 6B, or 6C. Metal barrels or drums.

(2) Spec. 10A or 10B. Wooden barrels or kegs.

(3) Spec. 15A. Wooden boxes, metal-lined, spec. 2F.

(c) **Igniters composed of black powder** may be included in shipments of propellant explosives.

(d) **Propellant explosives (unstable, condemned, or deteriorated smokeless powder for cannon or small arms)** must be packed submerged in water in containers complying with the following specifications:

(1) Spec. 5, 5A, 5B, 6B, or 6C. Metal barrels or drums.

(2) Spec. 10A or 10B. Wooden barrels or kegs.

(3) Spec. 15A. Wooden boxes, metal-lined, spec. 2F.

(4) Spec. 103 or 103W. Tank cars.

(5) Propellant explosives (unstable, condemned, or deteriorated smokeless powder for cannon or small arms) must not be offered for transportation by rail express.

(e) Each outside container must be plainly marked "PROPELLANT EXPLOSIVES, CLASS B" or "PROPELLANT EXPLOSIVES, CLASS B IN WATER," as the case may be. There may be added such additional marking as "Smokeless Powder for Cannon" or "Smokeless Powder for Small Arms," as the case may be.

(f) **Propellant explosives when offered for transportation by rail express** must be packed as follows (also authorized for transportation by carriers by rail freight, highway, or water):

(1) In tightly closed metal cans or fiber containers, not exceeding 1 pound each, or in inside metal cans or fiber containers containing not more than one grain of propellant, not exceeding 5 pounds each, packed in outside wooden boxes, spec. 15A, 15B, or 15C, or outside fiberboard boxes, spec. 12B, 23F, or 23H. Not more than 10 pounds of propellant powder may be shipped in one outside container. Each outside container must be plainly marked "PROPELLANT EXPLOSIVES."

(2) **Label. Each outside container of propellant explosives, when offered for transportation by rail express,** must have securely and conspicuously attached to it a square red label as described in § 73.412.

CLASS C EXPLOSIVES; DEFINITION

§ 73.100 Definitions of class C explosives. (a) Explosives, class C, are defined as certain types of manufactured articles which contain class A, or class B explosives, or both, as components but in restricted quantities, and certain types of fireworks. These explosives are further specifically described in this section.

(b) **Small-arms ammunition,** designed to be fired from a pistol, revolver, rifle, or shotgun held by the hand or by the shoulder, or machine guns of caliber less than .75, or blank remover cartridges fired from catapults and canopies, is fixed ammunition consisting of a metallic or paper cartridge case, a primer and a propelling charge, with or without bullet, shot, tear gas material, tracer components, or incendiary compositions or mixtures, but not including bullets loaded with high explosives.

(c) **Explosive cable cutters** are used for cutting cables, etc. They consist of a metal device containing a knife-edged component which is propelled by a small charge of an explosive compound.

(d) **Cordeau detonant fuse** is a fuse containing a core of pentaerythrite tetranitrate or cyclotrimethylene-trinitramine not exceeding 400 grains per linear foot, overspun with tapes, yarns and plastics or waterproofing compounds. Wire countering is permissible.

(e) **Percussion fuzes, combination fuzes, and time fuzes** are devices designed to ignite powder charges of ammunition or to initiate an intermediate charge (booster) in projectiles, bombs, etc. When such fuzes are assembled with booster charges they are properly described as "detonating fuzes," (see § 73.53 (g) (2)).

(f) **Tracer fuzes and tracers** are devices which are attached to projectiles and contain a slow-burning composition to show the flight of projectiles at night.

(g) **Cartridge bags, empty, with black powder igniters** consist of empty bags having attached thereto an igniter composed of black powder. (See § 73.93 (b), (c), and (d) when shipped with propellant explosives.)

(h) Igniters consist of fiberboard, plastic, paper or metal tubes containing a small quantity of igniting compound which is ignited by the action of a primer, pull wire or scratch composition.

(i) **Delay electric igniters** consist of small metal tubes containing a wire bridge in contact with a small quantity of ignition compound. The ignition compound is in contact with or in close proximity to a short piece of safety fuse.

(j) **Electric squibs** consist of small tubes or block containing a small quantity of ignition compound in contact wire a wire bridge.

(k) **Fuse lighters and fuse igniters** are small cylindrical hollow pasteboard or metal tubes containing an igniting composition in one end, the other end being open to permit it to be placed on safety fuse.

(l) **Safety squibs** are small paper tubes containing a small quantity of black powder. One end of each tube is usually twisted and tipped with sulfur.

(m) Instantaneous fuse is cotton yarn impregnated with meal powder. No restrictions other than packing in strong wooden boxes or barrels plainly marked "INSTANTANEOUS FUSE" are prescribed in this part.

(n) **Primers** are devices used to ignite the powder charges of ammunition or the black powder bursting charges of projectiles. For small-arms ammunition the primers are "small-arm primers" or "percussion caps."

(o) Safety fuse, consisting of a core of black powder overspun with yarns, tapes, and/or waterproofing compounds must be packed in outside fiberboard boxes, wooden boxes, wooden barrels, bales, or metal containers, and must be described for shipping purposes as "SAFETY FUSE." No other restrictions apply in this part.

(p) Toy paper caps, consisting of paper cap ammunition for toy pistols, in sheets, strips, rolls, or individual caps, must not contain more than an average of twenty-five hundredths of a grain of explosive composition per cap and must be packed in inside packages constructed of cardboard not less than 0.013 inch in thickness, metal not less than 0.008 inch in thickness, or noncombustible plastic not less than 0.015 inch in thickness, which shall provide a complete enclosure and the minimum dimensions of each side or end of such package shall be not less than ⅜ inch in height. Unless greater weight of composition is approved by the Bureau of Explosives, the number of caps in these inside packages shall be limited so that not more than 10 grains of explosive composition shall be packed into one cubic inch of space and not exceeding 17.5 grains of the explosive composition of toy caps shall be packed in any inside container. These inner containers must be packed in outside containers as specified in § 73.109.

(q) **Explosive rivets,** each containing not more than 375 milligrams of explosive composition, are exempt from specification packaging and labeling requirements when packed in pasteboard or other inside boxes in securely closed strong wooden boxes, fiberboard boxes or metal containers. Each outside container must be marked "EXPLOSIVE RIVETS." No other restrictions apply in this part.

(r) **Common fireworks** are fireworks devices suitable for use by the public and designed primarily to produce visible effects by combustion. Some small devices designed to produce audible effects are also included in this class. The types, sizes, and amount of pyrotechnic of these devices are limited as enumerated in this paragraph. No component, of any device listed in this paragraph, which is designed to produce an audible effect shall contain pyrotechnic composition in excess of 2 grains in weight. (Propelling or expelling charges consisting of a mixture of sulfur, charcoal, and saltpeter are not considered as designed to produce audible effects.) Any new device, not enumerated in this paragraph, must be approved by the Bureau of Explosives before being offered for transportation as Common Fireworks. Common fireworks must be in a finished state exclusive of mere ornamentation as supplied to the retail trade and must be so constructed and packed that loose pyrotechnic composition will not be present in packages in transportation. Fireworks, except articles defined in paragraphs (s) through (y), inclusive, of this section, other than common fireworks as defined in this paragraph, and those forbidden for transportation in § 73.51, are classed as Special Fireworks (see § 73.88 (d)).

(1) **Roman candles,** not exceeding ten balls spaced uniformly in the tube, total pyrotechnic composition not to exceed twenty grams each in weight. The inside tube diameter shall not exceed ⅜ inch.

(2) Sky rockets with sticks, total pyrotechnic composition not to exceed twenty grams each in weight. The inside tube diameter shall not exceed ½ inch. The rocket sticks must be securely fastened to the tubes.

(3) **Helicopter type rockets,** total pyrotechnic composition not to exceed twenty grams each in weight. The inside tube diameter shall not exceed ½ inch.

(4) **Cylindrical fountains,** total pyrotechnic composition not exceed seventy-five grams each in weight. The inside tube diameter shall not exceed ¾ inch.

(5) Cone **fountains,** total pyrotechnic composition not to exceed fifty grams each in weight.

(6) **Wheels,** total pyrotechnic composition not to exceed sixty grams for each driver unit or two hundred and forty grams for each complete wheel. The inside tube diameter of driverunits shall not exceed ½ inch.

(7) **Illuminating torches and colored fire in any form,** except items included in subparagraph (12), total pyrotechnic composition not to exceed one hundred grams each in weight.

(8) **Dipped sticks,** the pyrotechnic composition of which contains any chlorate or perchlorate shall not exceed 5 grams. Sparklers, the composition of which does not exceed 100 grams each and which contain no magnesium or magnesium and a chlorate or perchlorate, are not subject to the regulations in Parts 71-78 and 197.

(9) **Mines and shells** of which the mortar is an integral part, total pyrotechnic composition not to exceed forty grams each in weight.

(10) **Firecrackers and salutes with casings,** the extrenal dimensions of which do not exceed one and one-half inches in length or one-quarter inch in diameter, total pyrotechnic composition not to exceed two grains each in weight.

(11) Novelties consisting of two or more devices enumerated in this paragraph when approved by the Bureau of Explosives.

(s) Igniter cord consists of textile yarns and/or a wire uniformly covered with a combustible chemical mixture, with or without additional textile or wire counterings, waterproofing or finishing coatings which, when ignited, burns externally at various rates according to design. Igniter cord must be packed in strong, tight, outside fiberboard boxes or drums, wooden boxes or metal containers plainly marked "IGNITER CORD."

(t) Explosive auto alarms are tubular devices containing a small amount of explosive composition and igniting compound which is ignited by an electric spark. These devices must be so designed that they will neither burst nor cause external flame on functioning.

(u) Toy propellant devices and toy smoke devices consist of small paper or composition tubes or containers containing a small charge of slow burning propellant powder or smoke producing powder. These devices must be so designed that they will neither burst nor produce external flame on functioning and ignition elements, if attached, must be of a design approved by the Bureau of Explosives.

(v) Oil well cartridges are tubular devices consisting of a thin fiber, metal, or composition shell containing not more than 200 grains of propellant powder and having no ignition device or element.

(w) Fire extinguisher actuating cartridges consist of a small metal or fiber housing containing a small amount of initiating explosive and a propellant and are used to actuate the valves on remotely controlled fire extinguishers.

(x) Cigarette loads and trick matches must be of a type approved by the Bureau of Explosives and are described as follows:

(1) Cigarette loads consist of wooden pegs to which are affixed a small amount of explosive composition.

(2) Trick matches consist of book matches, strike anywhere matches, or strike-on-box matches which have small amounts of explosive or pyrotechnic composition affixed to the match stem just below the match head.

(y) Smoke candles, smoke pots, and smoke signals containing not more than 200 grams of pyrotechnic composition each, hand signal devices, very signal cartridges, and highway or railway fusees are devices designed to produce visible effects for signal purposes.

(z) Explosive release devices consist of a rod or link fitted with means for mechanical attachment to other apparatus or equipment and containing a small electrically initiated explosive charge which will break the rod or link upon functioning.

§ 73.101 Small-arms ammunition. (a) Small-arms ammunition must be packed in pasteboard or other inside boxes packed in securely closed strong wooden boxes, fiberboard boxes, or metal containers.

(b) Small-arms ammunition in pasteboard or other inside boxes, in addition to containers prescribed in paragraph (a) of this section, may be shipped when packed in the same outside container with nonexplosive and nonflammable articles; or with small-arms primers or percussion caps in quantity not to exceed 5 pounds. The weight of the small-arms ammunition packed with other articles must not exceed 55 pounds in outside fiberboard box, or 75 pounds in outside wooden box. The outside package must be a securely closed strong wooden or fiberboard container.

(c) Each outside package must be plainly marked "SMALL-ARMS AMMUNITION."

(d) Outside containers of cartridges with tear gas material must in addition to marking prescribed herein be marked "TEAR GAS CARTRIDGES" and must be labeled with "TEAR GAS" label. (See § 73.409 (a) (3) of this part for label.)

(e) No restrictions, other than proper description, packing and marking for small-arms ammunition and additional marking and labeling for tear gas cartridges are prescribed in this part for the transportation of small-arms ammunition and tear gas cartridges.

§ 73.102 Explosive cable cutters or explosive release devices. (a) Explosive cable cutters or explosive release devices must be packed in strong wooden or metal boxes.

(b) Each outside container must be plainly marked "EXPLOSIVE CABLE CUTTERS" or "EXPLOSIVE RELEASE DEVICES" and "HANDLE CAREFULLY—KEEP FIRE AWAY."

§ **73.103 Blasting caps not exceeding 1,000 caps.** (a) Blasting caps, blasting caps with safety fuse and electric blasting caps in quantities not exceeding 1,000 caps must be packed and marked as prescribed in § 73.66 and § 73.67 of this part.

(b) Blasting caps must not be offered for transportation by rail express, except as provided in § 73.86 of this part.

§ **73.104 Cordeau detonant fuse.** (a) Cordeau detonant fuse must not be packed in the same package with detonators or with any high explosive.

(b) Cordeau detonant fuse must be packed in wooden boxes or fiberboard boxes.

(c) Each outside container must be plainly marked "CORDEAU DETONANT FUSE—HANDLE CAREFULLY."

§ **73.105 Percussion, tracer, combination, time fuzes and tracers.** (a) Percussion, tracer, combination, time fuzes and tracers must be packed in strong, tight outside wooden boxes or spec. 23F fiberboard boxes, with special provision for securing individual packages of fuzes or tracers against movement in the box.

(b) The gross weight of one outside wooden box must not exceed 150 pounds, and the gross weight of one outside fiberboard box must not exceed 65 pounds.

(c) Each outside container must be plainly marked with proper descriptive name and also "HANDLE CAREFULLY."

(d) No restrictions other than proper description, packing, and marking are prescribed in this part for the transportation of percussion, tracer, time, or combination fuzes, or tracers.

§ **73.106 Cartridge bags, empty, with black powder igniters; igniters, safety squibs, electric squibs, delay electric igniters, and fuse lighters or fuse igniters.** (a) Cartridge bags, empty, with black powder igniters, igniters, safety squibs, electric squibs, delay electric igniters, and fuse lighters or fuse igniters must be packed in strong fiberboard or wooden boxes or wooden or metal barrels or drums properly described and properly marked with the name of the article packed therein.

§ **73.107 Primers, percussion caps, and empty grenades, primed.** (a) Primers (cannon, combination and small-arms), percussion caps, and empty grenades, primed, must be packed in strong, tight, outside wooden boxes, with special provision for securing individual packages against movement in the box.

(b) Empty cartridge cases, primed, must be packed in strong, tight, outside wooden or fiberboard boxes.

(c) **Small-arms primers containing anvils** must be packed in cellular inside packages, with partitions separating the layers and columns of the primers, so that the explosion of a portion of the primers in the completed shipping package will not cause the explosion of all the primers. They must be packed as prescribed in paragraph (a) of this section or in fiberboard boxes, spec. 12B, and equipped with corrugated fiberboard liners having Mullen or Cady test equal to or exceeding that of the box. Not more than 5,000 primers shall be packed in each fiberboard box.

(d) **Percussion caps** must be packed in metal or other inside boxes containing not more than 500 caps; the construction of the cap or packing and the kind and quantity of explosives in each must be such that the explosion of a part of the caps in the completed shipping package will not cause the explosion of all the caps.

(e) Small-arms primers and/or percussion caps may be packed with non-explosive and/or nonflammable articles, or with small-arms ammunition as provided in § 73.101 (b) of this part, the weight of the small-arms primers or percussion caps must not exceed 5 pounds in any such outside container.

(f) The gross weight of one outside package must not exceed 150 pounds.

(g) Each outside container must be plainly marked with proper descriptive name and also "HANDLE CAREFULLY."

(h) No restriction other than proper shipping name, packing and marking are prescribed in this part for the transportation of percussion caps, cannon primers, small-arms primers, combination primers, empty cartridge cases primed, or empty grenades primed.

§ **73.108 Common fireworks, signal flares, hand signal devices, railway or highway fusees, smoke signals, smoke candles, smoke pots, and very signal cartridges.** (a) Common fireworks, signal flares, hand signal devices, railway or highway fusees, smoke signals, smoke candles, smoke pots, and very signal cartridges, unless otherwise specifically provided for, must be securely packed in containers complying with the following specifications:

(1) Spec. 11B. Strong, tight, sparkproof wooden barrels.

(2) Spec. 15A, 15B, 16A, or 19A. Wooden boxes. Gross weight not to exceed 100 pounds, except gross weight of 500 pounds is authorized for very signal cartridges only.

(3) Spec. 12B. Fiberboard boxes. Gross weight not to exceed 65 pounds.

(4) **Firecrackers, Chinese,** in addition to containers specified in paragraph (a) (1), (2), and (3) of this section, may alse be transported in the package in which they are imported, provided these packages consist of wooden boxes, or fiberboard boxes, spec. 12B, in good condition, completely covered with strong matting and do not weigh more than 100 pounds, gross.

(5) Fireworks, such as sparklers or fusees, with match tip or head, or similar igniting point or surface, must have each individual tip, head, or similar igniting point or surface entirely covered and securely protected against accidental contact or friction.

(b) **Railway fusees, flares or highway signals** must be packed in containers complying with the following specifications:

(1) **Spec. 15A, 15B, 15C, 16A, 19A, or 19B.** Wooden boxes. Gross weight not to exceed 150 pounds for spec. 19B boxes; 200 pounds for others. When spec. 15C boxes are used, devices must be packed in air-tight inside metal containers.

(2) Spec. 12B. Fiberboard boxes, provided that ends of boxes are reinforced to prevent penetration of spikes through the outside container when the completed package, prepared for shipment, is subjected to two drops from a height of 4 feet on a solid surface and so as to strike diagonally with the spikes in a downward position. Gross weight not to exceed 65 pounds, except that gross weight not to exceed 75 pounds is authorized in boxes made in accordance with § 78.205-24 (a).

(3) Spec. 29. Mailing tubes, provided the penetration of the spikes of fusees (flares or highway signals), through the outside container is prevented by one of the methods speciafied for fiberboard boxes, spec. 12B, in paragraph (b) (2) of this section. Gross weight not to exceed 5 pounds.

(4) **Fusees, flares, pyrotechnic, or highway signals without spikes, or torches, pyrotechnic,** when offered for shipment may be packed in containers prescribed in this paragraph, omitting the protection required for these articles when equipped with spikes.

(5) Fusees, flares, or highway signals may be packed with nonexplosive or nonflammable articles provided the outside packages are marked as prescribed in this section.

(c) Except as otherwise specified herein the gross weight of one outside package containing common fireworks must not exceed 100 pounds.

(d) Each outside package must be plainly marked in letters not less than 7/16 inch in height "COMMON FIREWORKS," "SIGNAL FLARES," "HAND SIGNAL DEVICES," "RAILWAY FUSEES," "HIGHWAY FUSEES," "SMOKE SIGNALS," "SMOKE CANDLES," "SMOKE POTS," or "VERY SIGNAL CARTRIDGES," as the case may be, and with the additional words "HANDLE CAREFULLY—KEEP FIRE AWAY."

§ 73.109 **Toy caps.** (a) Toy caps must be packed in containers complying with the following specifications:

(1) Spec. 15A, 15B, 16A, or 19A. Wooden boxes. Gross weight not to exceed 150 pounds.

(2) Spec. 12B. Fiberboard boxes. Gross weight not to exceed 65 pounds.

(3) Toy caps, in addition to containers specified in sub-paragraphs (a) (1) and (2) of this section, may be transported in the package in which they are imported, provided the package consists of a wooden box, metal-lined, in good condition, and weighing not over 100 pounds gross. Inside packages must be as defined in § 73.100 (p).

(b) Toy caps may be packed with nonexplosive or nonflammable articles provided the outside containers are marked as prescribed herein.

(c) Toy paper caps of any kind must not be packed with fireworks.

(d) Each outside container must be plainly marked "TOY CAPS—HANDLE CAREFULLY."

§ 73.110 **Charged oil well jet perforating guns, total explosive content in guns not exceeding 15 pounds per motor vehicle.** (a) Charged oil well jet perforating guns transported by motor vehicles operated by private carriers engaged in oil well operations in which the total weight of the explosive contents of shaped charges assembled to guns being transported does not exceed 15 pounds per such vehicle must be packed as prescribed in § 73.80 (b), (c), (d) and (e).

(b) Charged oil well jet perforating guns must not be offered for transportation by carriers by rail freight, rail express, rail baggage, water, or by common or contract carriers by public highway.

§ 73.111 **Cigarette loads, explosive auto alarms, toy propellant devices, toy smoke devices, and trick matches.**

(a) Cigarette loads, explosive auto alarms, toy propellant devices, toy smoke devices, and trick matches must be packed in containers complying with the following specifications:

(1) Spec. 15A, 15B, 16A, or 19A. Wooden boxes. Gross weight not to exceed 150 pounds.

(2) Spec. 12B. Fiberboard boxes. Gross weight not to exceed 65 pounds.

(3) Each outside container must be plainly marked with the proper descriptive name and "HANDLE CAREFULLY."

§ 73.112 **Oil well cartridges.** (a) Oil well cartridges must be so packed that the explosive composition does not exceed 20 grains per cubic inch of space in the outside shipping container and must be in specification containers as follows:

(1) Spec. 15A, 15B, 16A, or 19A. Wooden boxes. Gross weight not to exceed 150 pounds.

(2) Spec. 12B. Fiberboard boxes. Gross weight not exceed 65 pounds.

(3) Each outside container must be plainly marked with the name "OIL WELL CARTRIDGE" and "HANDLE CAREFULLY."

§ 73.113 **Detonating fuzes, class C.** (a) Detonating fuzes, class C, are used in the military service to detonate high explosives bursting charges of projectiles, mines, bombs, torpedoes and grenades. They contain a detonator and a quantity of a high explosive. Detonating fuzes, class C, must be made and packed so that they will not cause functioning of other fuzes, explosives or explosive devices if one of the fuzes detonates in a shipping container or in adjacent containers.

(b) Detonating fuzes, class C, must be packed and well secured in strong tight outside wooden or metal boxes. The gross weight of the outside wooden or metal box containing detonating fuzes, class C must not exceed 190 pounds.

(c) Each outside package must be plainly marked "DETONATING FUZES, CLASS C EXPLOSIVES—HANDLE CAREFULLY."

§ 73.114 **Fire extinguisher actuating cartridges.** (a) Fire extinguisher actuating cartridges must be packed in strong wooden or fiberboard boxes.

(b) Each outside container must be plainly marked "FIRE EXTINGUISHER ACTUATING CARTRIDGES—HANDLE CAREFULLY."

(c) When shipped as components with fire extinguisher and with not more than 2 cartridges for each extinguisher, they are exempt from Parts 71-78.

SUBPART C—FLAMMABLE LIQUIDS; DEFINITION AND PREPARATION

§ 73.115 **Flammable liquids; definition.** (a) A flammable liquid for the purpose of Parts 71-78 is any liquid which gives off flammable vapors (as determined by flash point from Tagliabue's open-cup tester, as used for test of burning oils) at or below a temperature of 80°F.

(b) Flammable liquids are described as viscous flammable liquids (see § 73.119 (j)) when viscosity is determined by one of the following methods:

(1) The viscosity of the liquids must be determined in a Stormer viscosimeter with an actuating weight of 400 grams and with the liquid maintained at a temperature of 28°C. The cylinder of the viscosimeter must be immersed in the liquid.

(2) For transparent liquids the sample may be tested in a vertical glass tube, 1 inch inside diameter by approximately 13 inches long, having two marks 19 inches apart engraved thereon, the lower mark being 2 inches above the bottom of the tube; the liquid to be tested shall be poured into the tube until its surface rises one-half inch above the upper mark and must be maintained at a temperature of 28°C. during the test; a polished steel ball one-fourth inch in diameter shall be supported one-half inch above the surface of the liquid at the center of the tube and dropped therein.

(3) When the speed of the cylinder in the first test does not exceed 10 revolutions per 13 seconds, or the time required in the second test for the steel ball to fall the vertical distance between the two lines upon the glass tube is not less than 4 seconds the material is classed as "viscous."

§ 73.116 **Outage.** (a) Outage for containers offered for transportation by carriers by rail freight, rail express, highway, or water, except as otherwise specifically provided in this part, must be as prescribed in paragraphs (b) to (h) of this section.

(b) Containers must not be entirely filled. Sufficient interior space must be left vacant to prevent leakage or distortion of containers due to the expansion of the contents from increase of temperature during transit. This outage must be calculated to the total capacity of the container.

(c) In packages containing alcohol, cologne spirits, high wines, or other distilled spirits of 150 proof or over, the vacant interior space must be the maximum permitted by the United States Internal Revenue regulations.

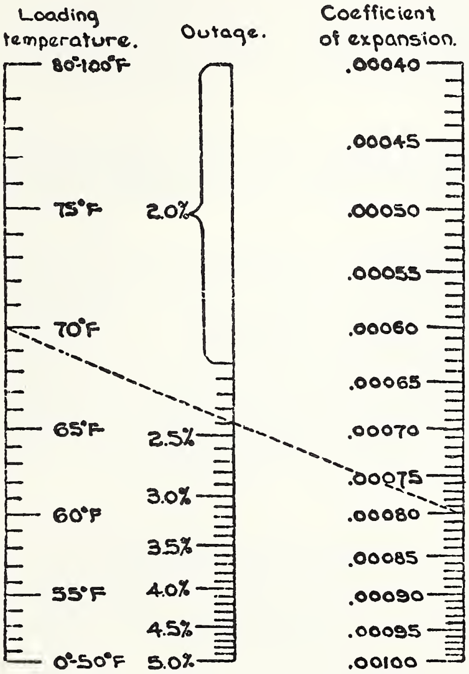
(d) Flammable liquids must not be loaded into domes of tank cars. If the dome of the tank car does not provide sufficient outage, then vacant space must be left in the shell to make up the required outage.

(e) Flammable liquids having vapor pressure of 16 pounds per square inch absolute at 100°F. or less must be so loaded in tank cars that the outage shall be not less than 2 percent.

(f) Flammable liquids having a vapor pressure exceeding 16 pounds per square inch absolute at 100°F. for which minimum outage is not otherwise specifically provided herein, when loaded in uninsulated tank cars, must be so loaded that the minimum outage will be the greatest of the following values:

(1) Dome capacity.
(2) Two percent of total capacity of tank and dome.
(3) Outage as shown in paragraph (g) of this section.

(g) Outage chart for flammable liquids:



Example: Suppose the temperature of the liquid at time of loading is 70°F. and its coefficient of expansion is 0.00080; lay a ruler on the chart running from 70° to 0.00080 as shown by the dotted line and the required outage is 2.4 percent where the ruler crosses the outage scale.

The following coefficients of expansion per degree Fahrenheit of the principal flammable liquids shall be used in determining outages:

Acetone	0.00085
Amyl acetate	.00068
Benzol (benzene)	.00071
Carbon bisulfide	.00070
Ether	.00098
Ethyl acetate	.00079
Ethyl (grain) alcohol	.00062
Methyl (wood) alcohol	.00072
Toluol (toluene)	.00063

Gasoline or naphtha:

50-55° A. P. I[1]	.00055
55.1-60° A. P. I.[1]	.00060
60.1-65° A. P. I.[1]	.00065
65.1-70° A. P. I.[1]	.00070
70.1-75° A. P. I.[1]	.00075
75.1-80° A. P. I.[1]	.00080
80.1-85° A. P. I.[1]	.00085
85.1-90° A. P. I.[1]	.00090

[1] ° A. P. I. (American Petroleum Institute), according to the following formula:

$$° \text{A.P.I.} = \frac{141.5}{\text{specific gravity}} - 131.5$$

(h) No cargo tank or compartment thereof used for the transportation of any flammable lquid shall be liquid full. The vacant space (outage) in a cargo tank or compartment thereof used in the transportation of flammable liquids shall be not less than 1 percent; sufficient space (outage) shall be left vacant in every case to prevent leakage from or distortion of such tank or compartment by expansion of the contents due to rise in temperature in transit.

§ 73.117 Closing and cushioning. (a) All containers must be tightly and securely closed. Inside containers must be cushioned as prescribed, or in any case when necessary to prevent breakage or leakage.

§ 73.118 Exemptions for flammable liquids. (a) Flammable liquids, except those enumerated in paragraph (c) of this section, in inside metal containers not over 1 quart capacity each, packed in strong outside containers, except as otherwise provided, are exempt from specification packaging, marking, and labeling requirements, except that marking name of contents on outside container is required for shipments via carrier by water. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817, and Part 197.

(b) Flammable liquids, except those enumerated in paragraph (c) of this section, in inside containers having a capacity not over 1 pint or 16 ounces by weight each, packed in strong outside containers, are exempt from specification packaging, marking, and labeling requirements, except that marking name of contents on outside container is required for shipments via carrier by water. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817, and Part 197.

(c) The following articles in any quantity are not exempt from any of the provisions of paragraphs (a) and (b) of this section:

(1) Acrolein.
(2) Carbon bisulfide (disulfide).
(3) Ethyl chloride.
(4) Ethyl trichlorosilane.
(5) Ethylene oxide.
(6) Flammable liquids which are also corrosive liquids or oxidizing materials under this part.
(7) Lithium aluminum hydride (ethereal).
(8) Nickel carbonyl.
(9) Pentaborane.
(10) Spirits of nitroglycerin in excess of one percent by weight.
(11) Trichlorosilane.
(12) Zinc ethyl.
(13 Ethylene imine, inhibited.
(14) Zirconium, metallic, solutions, or mixtures thereof, liquid.
(15) Amyl mercaptan.
(16) Butyl mercaptan.
(17) Ethyl mercaptan.
(18) Aliphatic mercaptan mixtures.
(19) Isopropyl mercaptan.
(20) Propyl mercaptan.
(21) Vinyl trichlorosilane.
(23) Methylchloromethyl ether, anhydrous.
(24) Methylhydrazine.
(25) Uns-dimethylhydrazine.
(26) Acrolein, inhibited.
(27) Aluminum triethyl.
(28) Aluminum trimethyl.
(29) Dimethyldichlorosilane.
(30) Ethyldichlorosilane.
(31) Methyltrichlorosilane.
(32) Methyl vinyl ketone, inhibited.
(33) Peroxides, organic, liquids, n.o.s.
(34) Trimethylchlorosilane.
(35) Methyl dichlorosilane.
(36) Pyroforic fuel.

§ 73.119 **Flammable liquids not specifically provided for.** (a) **Flammable liquids with flash point 20°F. or below.** Flammable liquids with flash point 20°F. or below and having vapor pressure (Reid[1] test) not over 16 pounds per square inch, absolute, at 100°F., other than those for which special requirements are prescribed in this part, must be prepared for shipment in specification containers of a design and constructed of materials that will not react dangerously with or be decomposed by the chemical packed therein, as follows (see paragraphs (c) to (i) of this section for high pressure liquids, paragraphs (j) to (l) of this section for viscous liquids, and paragraphs (m) of this section for flammable liquids which are also oxidizing materials or corrosive liquids):

(1) Spec. 1A, 1C, or 1D. Carboys, glass, boxed or in barrels or kegs, capacity not over 5 gallons, except capacity not over 6.5 gallons authorized for Spec. 1D. Must be closed, and when reused must be reconditioned and tested, as provided in the specification.

(2) Spec. 5, 5A, 5B, 5C, or 5M. Metal barrels or drums, with openings not exceeding 2.3 inches in diameter.

(3) Spec. 17E. Metal drums (single-trip), not over 5 gallons capacity, without opening except bunghole not exceeding 2.3 inches in diameter. (See also paragraph (a) (16) this section.)

(4) Spec. 17C. Metal drums (single-trip), with openings not exceeding 2.3 inches in diameter.

(5) Spec. 10A. Wooden barrels or kegs.

(6) Spec. 11A or 11B. Wooden barrels or kegs with inside containers which must be glass or earthenware, not over 1 gallon each; metal pails, kits, or cans, not over 2 gallons each.

(7) Spec. 12B. Fiberboard boxes with inside containers which must be glass or eartherware, not over 1 quart each; metal cans, not over 1 gallon each.

(8) Spec. 15A, 15B, 15C, 16A, 19A, or 19B. Wooden boxes with inside containers which must be metal pails, kits, or cans, not over 10 gallons each or inside glass or earthenware containers not over 1 gallon each, except that glass or earthenware containers up to 3 gallons each are authorized when only one inside container is packed in each outside container.

(9) Spec. 21A, 21B, 22A, or 22B. Fiber drums and plywood drums with a single inside glass, earthenware, or metal container of not over 1 gallon capacity in each drum. Inside container must be so cushioned at top, sides, and bottom, as to prevent breakage or leakage in transit.

(10) Spec. 42B or 42C. Aluminum barrels or drums.

(11) Cylinders as prescribed for any compressed gas, except acetylene.

(12) Spec. 103, 103-W, 103AL-W, 103D-W, 104, 104-W, 105A100, 105A100-W, 105A100AL-W, 105A300-W, 105A300AL-W, 105A400-W, 105A500-W, 105A600-W, ARA-11[2], ARA-III[2], ARA-IV[2], or ARA-IV-A[2]. Tank cars. For cars equipped with expansion domes, manhole closures must be so designed that pressure will be released automatically by starting the operation of removing the manhole cover. (See § 73.432 for shipping instructions.)

(14) Spec. 15X. Wooden boxes with inside metal containers. For shipment by common carriers by water to noncontinguous territories or possessions of the United States and foreign countries; shipments from inland points in the United States which are consigned to such destinations are authorized to be transported to ship side by rail freight in carload lots only and by motor vehicle in truckload lots only.

(15) Spec. 17X. Metal drums (single-trip). For shipment by common carriers by water to noncontinguous territories or possessions of the United States and foreign countries; shipments from inland points in the United States which are consigned to such destinations are authorized to be transported to ship side by rail freight in carload lots only and by motor vehicle in truckload lots only.

(16) Spec. 17E. Metal drums (single-trip), not over 55 gallons capacity, not less than full 19 gauge body and head sheets for not over 30-gallon drums, and not less than full 18 gauge body and head sheets for not over 55-gallon drums, with openings not exceeding 2.3 inches in diameter. When transported by rail or highway, authorized only for carload and truckload shipments.

NOTE 1: Because of the present emergency and until further order of the Commission, l. c. l. and l. t. l. shipments will be permitted.

(17) Spec. MC 300, MC 301, MC 302, MC 303, or MC 304. Tank motor vehicles.

NOTE 1: Compartmented tank motor vehicles having campartments not equipped with emergency valves or baffles are authorized provided compartments used for dangerous articles are so equipped when required by the specification and provided each compartment not so equipped is plainly marked near the manhole "This compartment not to be used for flammable liquids."

(19) Spec. 5L. Metal barrels or drums for gasoline shipments offered by or consigned to the Departments of the Army, Navy, and Air Force of the United States Government or Allies. Use of this container will be permitted because of the present emergency and until further order of the Commission.

(20) Spec. 12D. Fiberboard boxes with inside containers which must be glass or earthenware not over one gallon each; authorized for not more than 75 pounds gross weight; not to contain more than 4 such inside containers if their capacity is greater than 5 pints each. Use of this container will be permitted because of the present emergency and until further order of the Commission.

(21) Gasoline samples in boxes of metal not lighter than 20 gauge, United States standard, having hinged cover securely closed, and containing not more than 5 inside rectangular metal cans with screw cap closure, each having a capacity not to exceed ½ gallon, may be shipped when consigned to state laboratories for examination.

(b) **Flammable liquids with flash point above 20° to 80°F.** Flammable liquids with flash point above 20° F. to 80°F. and having vapor pressure (Reid[1] test) not over 16 pounds per square inch, absolute, at 100° F., other than those for which special requirements are prescribed in this part, must be prepared for shipment in specification containers of a design and constructed of materials that will not react dangerously with or be decomposed by the chemical packed therein, as follows (see paragraphs (c) to (i) of this section for high pressure liquids and paragraph (m) of this section for flammable liquids which are also oxidizing materials or corrosive liquids):

(1) Containers as specified in paragraph (a) of this section, except that openings greater than 2.3 inches in diameter in barrels and drums are authorized when permitted by the specification, and also the following.

(2) Spec. 17E or 17H, Metal drums (single-trip).

(3) Spec. 10B, wooden barrels or kegs.

NOTE 1: Because of the present emergency and until further order of the Commission, wooden whiskey barrels, properly recoopered, which comply with all the provisions of spec. 10B, are also authorized. Marking is required on the head of each container, by the reconditioner, by hot branding or legible stenciling, as follows:

ICC-10B

Name or symbol (letters) of reconditioner; this must be registered with the Bureau of Explosives and located just above, below, or following the mark ICC-10B.

Size of marking (minimum) ¾ inch high.

(4) Spec. 12B. Fiberboard boxes with inside containers which must be glass, earthenware, or metal, not over 1 gallon each. Packages containing inside glass or earthenware containers must not contain more than 4 such inside containers if their capacity is greater than 5 pints each.

NOTE 1: Because of the present emergency and until further order of the Commission, fiberboard boxes, spec. 12B, § 78.205-26 (a), with one inside rectangular metal can, spec. 2F, not to exceed 5 gallons capacity, are authorized. Gross weight of completed package not over 65 pounds.

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[2] Use of existing tank cars authorized, but new construction not authorized.

(5) Spec. 12E. Fiberboard box with 1 or 2 rectangular metal inside containers of not over 5 gallons capacity each.

(6) Spec. 6K. Metal barrels or drums which must be constructed of Type 304 stainless steel, having heads with minimum convexity of ⅝ inch welded to the body, and be equipped at both heads with 12 gauge chime reinforcements. Body seams shall be welded. Drums shall be equipped with I-bar rolling hoops.

(c) **Flammable liquids for which other special packing requirements are not prescribed.** Flammable liquids for which other special packing requirements are not prescribed in this part, must be shipped, depending upon their Reid[1] vapor pressures as prescribed in paragraphs (d) to (i) of this section.

(d) **When the vapor pressure does not exceed 16 pounds per square inch, absolute, at 100°F.** When the vapor pressure does not exceed 16 pounds per square inch, absolute, at 100°F., as prescribed in paragraphs (a) and (b) of this section.

(e) **When vapor pressure exceeds 16 pounds per square inch absolute, at 100°F.** When the vapor pressure exceeds 16 pounds per square inch, absolute, at 100°F., but does not exceed 27 pounds per square inch, absolute, at 100°F., flammable liquids must be packed in specification containers as follows:

(1) As prescribed in paragraph (a) (1) to (11) of this section, except spec. 10A and 17E. Bung labels required, for metal barrels and drums, as prescribed in paragraph (i) of this section.

(2) Spec. 103, 103-W, 103AL-W, 103D-W, 104, 104-W, 105A-100, 105A100-W, 105A100AL-W, 105A300-W, 105A300AL-W, 105A400-W, 105A500-W, 105A600-W, ARA-11[2], ARA-III[2], ARA-IV[2], or ARA-IV-A[2]. Tank cars. Cars having expansion domes must be equipped with manhole closures, identification marks, and dome placards as prescribed in (f) (4), (g), (h), and (h) (1) of this section. (See Note 1 of paragraph (f) (3) of this section.)

(3) Spec. MC 300, MC 301, MC 302, MC 303 or MC 304. Tank motor vehicles.

(f) **When the vapor pressure exceeds 27 pounds per square inch, absolute, at 100°F.** When the vapor pressure exceeds 27 pounds per square inch, absolute, at 100°F., but does not exceed 40 pounds per square inch (see Note 2), absolute, at 100°F.,. flammable liquids must be packed in specification containers as follows:

(1) Spec. 5 or 5A. Metal barrels or drums, with openings not exceeding 2.3 inches in diameter. Bung labels required as prescribed in paragraph (i) of this section.

(2) Cylinders as prescribed for any compressed gas except acetylene.

(3) Spec. 105A100, 105A100-W, 105A100AL-W, 105A300-W, 105A300AL-W, 105A400-W, 105A300-W, 105A600-W, or ARA-IV-A[2] (see Note 1 of this subparagraph). Tank cars. Spec. 104 and ARA-IV[2] tank cars are authorized under the conditions prescribed in paragraphs (f) (4), (g), (h), and (h) (1) of this section and Note 3 of this subparagraph.

NOTE 1: Tanks built in compliance with American Railway Association specifications for class IV-A[1] tank cars authorized for use effective October 1, 1925, may be continued in service for the transportation of ethyl chloride and other liquids which do not have a vapor pressure exceeding 28 pounds per square inch, gauge pressure, at 100°F., provided there is stenciled on each side of the tank immediately below the valve protecting housing the words "Liquids having vapor pressure exceeding 28 pounds per square inch at 100°F. must not be loaded into this tank" in letters and figures at least 1 inch high. These tank cars must be retested as prescribed in current spec. 105A100, except that safety valves must open at pressure not exceeding 35 pounds, and be vapor tight at 28 pounds per square inch.

NOTE 2: When the vapor pressure exceeds 40 pounds per square inch, absolute, at 100° F., these flammable liquids are classed as flammable compressed gases and must be described, packed, and shipped as prescribed for such articles.

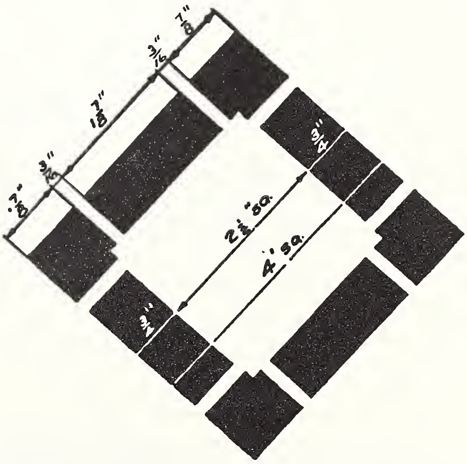
NOTE 3: Spec. 104 or 104W or ARA-IV[1] tank cars are authorized provided that they are equipped with approved fittings designed to provide for the loading, unloading, gauging, sampling, and taking temperature of the contents without removing the manhole closure; that safety valves are set to open at pressure of 35 pounds (with a tolerance of plus or minus 3 pounds), and are vapor tight at 28 pounds per square inch, gauge pressure; that bottom discharge outlets are of the same type as authorized for specification 104 or 104W tank cars; and that there is stenciled on each side of the tank above the specification mark, in letters and figures at least 1 inch high. "For vapor pressures not exceeding 40 pounds per square inch, absolute, at 100°F." Because of the present emergency and until further order of the Commission, spec. ICC-104 or 104W tank cars, equipped with safety valves set to open at pressure of 35 pounds (with a tolerance, of plus or minus 3 pounds) and which are vapor tight at 28 pounds per square inch, gauge pressure, are authorized provided that they are stenciled as required above.

(4) Spec. 103, 103-W, 103AL-W, 104, 104-W, ARA-II[1], ARA-III[1], or ARA-IV[1]. Tank cars. Cars must have their manhole closures equipped with approved safeguards making removal of closures from manhole openings practically impossible while car interior is subjected to vapor pressure of lading. These cars must be stenciled on each side of domes in line with the ladders, and in a calor contrasting to the color of the dome, with the identification mark as prescribed in paragraph (g) of this section.

(5) Spec. MC 304 Tank motor vehicle.

(g) **Manhole closure identification mark.**

(Reduced size)



(h) **Dome placards.** Spec. 103, 103-W, 103AL-W, 104, 104-W, ARA-II[1], ARA-III[1], or ARA-IV[1]. Tank cars. Cars loaded with materials described in paragraphs (e) and (f) of this section must, in addition to the "Dangerous" placards be protected by special dome placards, at least 4⅛ by 10⅞ inches, with legible wording as follows.

DOME PLACARD

(Reduced Size)
(Black printing on white)

10⅞ Inches

4⅛ Inches

AVOID ACCIDENTS

DO NOT REMOVE THIS DOME COVER
WHILE GAS PRESSURE EXISTS IN TANK

KEEP LIGHTED LANTERNS AWAY

NOTE 1: For tank car equipped with both inner and outer manhole covers, and when removal of inner cover is not necessary to unload the car, the word "inner" may be substituted for the word "this" in the dome placard.

(1) Dome placards must be applied one on each side of dome and one on the top near the manhole in line with the ladders. Dome placards may be of white paper securely pasted to the dome, or of strong tag board foı use in suitable holders; or the wording of the dome placard may be stenciled on the dome of car and remain thereon as long as it is used in the service which requires these special placards.

(i) **Bung label.** Flammable liquids as described in the paragraphs (e) and (f) of this section, shipped in metal drums or barrels in addition to the standard red caution label prescribed in § 73.405 of this part, must be labeled near the bung with a white rectangular label or tag measuring 5 by 3 inches, bearing the following wording:

BUNG LABEL
(Reduced size)
(Black printing on white)

5 Inches

3 Inches

CAUTION **Unscrew This Bung SLOWLY**

Do not unscrew entirely until all interior pressure has escaped through the loosened threads.

REMOVE BUNG IN OPEN AIR. Keep all open flame lights and fires away. Inclosed Electric Lights are safe.

(j) **Viscous flammable liquids.** Flammable liquids having a viscosity as determined by one of the methods prescribed in § 75.115 (b) must be shipped in specification containers as prescribed in paragraphs (k) or (l) of this scetion.

(k) **Viscous flammable liquids having a vapor pressure which does not exceed 16 pounds per square inch, absolute, at 100°F.** (See paragraphs (c) to (i) of this section for higher pressure liquids) must be prepared for shipment in containers as follows:

(1) As prescribed in paragraphs (a) or (b) of this section: irrespective of flash point.

(2) Spec. 6A, 6B, 6C, or 42F. Metal barrels or drums.

(3) Spec. 37A or 37B. Metal drums (single-trip) not over 5 gallons with welded side seams.

(4) Spec. 42F. Aluminum barrels or drums.

(l) **Viscous flammable liquids with flash point above 20°F. to 80°F. and having a vapor pressure which does not exceed 18 pounds per square inch, absolute, at 100°F.** Viscous flammable liquids with flash point above 20°F to 80°F. and having a vapor pressure which does not exceed 18 pounds per square inch, absolute, at 100°F. must be prepared for shipment in containers as follows:

(1) As prescribed in paragraphs (e) to (i) of this section.

(2) Spec. 17E or 17H. Metal drums (single-trip).

(m) **Flammable liquids which are also oxidizing materials or corrosive liquids.** Flammable liquids which are also oxidizing materials or corrosive liquids as defined in §§ 73.151 and 73.240 of this part must be packed as follows:

(1) Spec. 1A or 1D. Carboys, glass, boxed, capacity not over 5 gallons for spec. 1A, and 6.5 gallons for spec. 1D.

(2) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside containers which must be glass or earthenware, not over 1 gallon each, cushioned with incombustible packing material in sufficient quantity to absorb the contents of the inner container.

(3) Spec. 12B. Fiberboard boxes with inside containers which must be glass or earthenware, not over 1 quart each, cushioned with incombustible packing material in sufficient quantity to absorb the contents of the inner container.

(4) Spec. 5, 5A, 5B, 5C, 17C (single-trip) or 17E (single-trip). Metal barrels or drums not over 15 gallons capacity. Authorized only for materials which will not react dangerously with the drum metal, or be decomposed by contact with it.

§ **73.120 Automobiles, motorcycles, tractors, or other self-propelled vehicles.** (a) Automobiles, motorcycles, tractors, or other self-propelled vehicles, equipped with gasoline or other fuel tanks, provided such tanks are securely closed exempt from specification packaging, marking, and labeling requirements, except that marking name of contents on outside container is required for shipments via carrier by water. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations. When offered for transportation by carriers by rail freight or highway, drainage of fuel tanks is not required. When offered for transportation by rail express, fuel tanks must have been drained and securely closed.

(b) **Engines or motors (internal combustion).** Engines or motors (internal combusition) employing liquid fuel classed as flammable liquid in this chapter, whether shipped separately or as a part of other apparatus, unless specifically exempt in paragraph (a) of this section, must have their fuel tanks completely drained.

(c) **Truck bodies or trailers on flat cars.** Truck bodies or trailers with automatic heating or refrigerating equipment of the flammable liquid type may be shipped with fuel tanks filled and equipment operating or inoperative, when used for the transportation of other freight and loaded on flat cars as part of a joint rail-highway movement, provided the equipment and fuel supply are of a type approved by the Bureau of Explosives. The heating or refrigerating units are exempt from specification packaging, marking, and labeling requirements in this service and shall be considered as carrier's equipment but not as shipments.

§ **73.121 Carbon bisulfide (disulfide).** (a) Carbon bisulfide must be packed in specification containers as follows:

(1) Spec. 11A or 11B. Wooden barrels or kegs with glass, earthenware, or metal inside containers not over 5 pints capacity each.

(2) Spec. 12B. Fiberboard boxes with inside containers which must be glass or earthenware, not over 1 pint each, or metal cans, not over 1 quart each. Outside containers not to exceed 65 pounds gross weight.

(3) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside metal containers, sepc. 2A; or with inside glass or earthenware containers not over 5 pints capacity each.

(4) Spec. 17E. Metal drums (single-trip) not over 5 gallons capacity each, with openings not exceeding 2.3 inches in diameter.

(5) Spec. 5, 5A or 17C (single-trip). Metal barrels or drums not over 55 gallon, capacity each, with openings not exceeding 2.3 inches in diameter.

(6) Tank cars as prescribed in § 73 119 (a) (12) of this part. See § 73.432 of this part for shipping instructions.)

(b) Carbon bisulfide (disulfide) must not be offered for transportation by rail express.

§ **73.122 Acrolein, inhibited.** (a) Acrolein must be inhibited and when offered for transportation by carriers by rail freight, highway, or water must be packed in specification containers as follows:

(1) Spec. 5A. Metal drums not over 55 gallons capacity each.

(2) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside metal containers, spec. 2A, not over 5 gallons capacity each.

(3) Spec. 105A500W tank cars, which must be stenciled near the specification number "FOR ACROLEIN ONLY."

NOTE 1: Spec. 105A500W tank cars stenciled 105A300W because of safety valve settings may also be used. Safety valve settings as low as 150 pounds per square inch are authorized provided cars are stenciled above the commodity stenciling "Safety valve **** lbs.," the stars to be replaced by the appropriate figures to indicate the valve setting.

(b) Acrolein must be inhibited and when offered for transportation by rail express must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, 19A, or 12B, Wooden or fiberboard boxes having not more than one inside container of glass not exceeding one quart capacity, securely cushioned within a metal container.

§ 73.123 **Ethyl chloride.** (a) Ethyl chloride must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with glass, earthenware, or metal inside containers not over 1 pound capacity each.

(2) Spec. 12B. Fiberboard boyes with glass, earthenware, or metal inside containers not over 1 pound capacity each. Outside containers not to exceed 65 pounds gross weight.

(3) Spec. 5A. Metal barrels or drums not over 33 gallons capacity each.

(4) Cylinders as prescribed for any compressed gas, except acetylene.

(5) Spec. 105A100, 105A100-W, 105A300-W, 105A400-W, 105A500-W, 105A600-W, or ARA-IV-A[1]. Tank cars. See Note 1 of § 73.119 (f) (3). (See § 73.432 for shipping instructions.)

(6) Spec. MC 330. Tank motor vehicle.

(b) Outage for all containers except lagged tank cars, must be 7.5 percent or more at 70°F. For lagged tank cars, 4 percent or more at 70°F.

§ 73.124 **Ethylene oxide.** (a) Ethylene oxide must be packed in specification containers as follows and copper or copper bearing alloys shall not be used in any part of a container, container valve or other container appurtenance if that part is normally in contact with ethylene oxide liquid or vapor.

(1) Spec. 15A, 15B, 15C, or 16A wooden boxes and spec. 12B, fiberboard boxes, with metal inside containers not over 12-ounce capacity each. Each inside container must have a minimum bursting strength of 180 psig as prepared for shipment and be provided with a safety vent having a minimum diameter of 0.1023 inch and closed with fusible metal having a yield temperature of 157 to 170°F. The safety vent opening shall be hot tinned before filling with fusible metal. Filling shall be such that the container will not be liquid full below 185°F. Each inside container must be completely insulated, except for top closure, with two coats of heat-retardant paint, of type approved by the Bureau of Explosives, applied over suitable primer and finished with suitable waterproof paint; or with other equally efficient insulation approved by the Bureau of Explosives. Not more than 12 inside containers nor more than one layer of containers may be packed in one outside container.

(2) Cylinders as prescribed for any compressed gas, except acetylene, not exceeding 30 gallons water capacity nominal, which meet the following requirements. All cylinders shall be seamless or steel welded. Cylinders shall be equipped with safety devices of the fusible plug type with threaded straight bore orifice with yield temperature of 157 to 170°F. having a minimum vent area of 0.0055 sq. in. per lb. of water capacity of the container for containers not over one gallon capacity and 0.0012 sq. in. per lb. of water capacity of the container for all containers over one gallon capacity. Each cylinder must be tested for leakage at a pressure of at least 15 p.s.i. gauge with an inert gas before each refilling. Filling shall be such that the container will not be liquid full at 185°F. Pressurizing valves and eductor tubes must be provided for all containers over one gallon capacity. Cylinders having a water capacity in excess of one gallon shall be insulated with three coats of heat-retardant paint, of type approved by the Bureau of Explosives, applied over suitable primer and finished with suitable waterproof paint; or with other equally efficient insulation approved by the Bureau of Explosives.

(3) In addition to specification containers prescribed in this section, ethylene oxide may be shipped when packed in strong combustible outside containers, with inside containers which must be securely sealed glass ampules or vials, contents not over 100 grams each, cushioned in vermiculite or equally efficient incombustible cushioning material. Not more than 100 grams of ethylene oxide shall be packed in any such outside container.

(4) Spec. 5P. Lagged steel drums not over 61 gallons capacity each. Drums must be equipped with safety devices of the fusible plug type with threaded straight bore orifice, with yield temperature of 157 to 170° F. having a minimum vent area of 0.0055 sq. in. per lb. of water capacity of the container for containers not over one gallon capacity and 0.0012 sq. in. per lb. of water capacity of the container for all containers over one gallon capacity. Each drum must be tested for leakage at a pressure of at least 15 p.s.i. gauge with an inert gas before each refilling; top head of each drum must be plainly marked with paint "Keep This End Up." Filling shall be such that the container will not be liquid full below 185°F. and the maximum filling for 61 gallon drums must not exceed 55 gallons of ethylene oxide at 60°F.

(5) Spec. 105A100, 105A100-W, or ARA-IV-A[1]. Tank cars. See Note 1 of § 73.119 (f) (3). (See § 73.432 for shipping instructions.)

NOTE 1: Because of the present emergency and until further order of the Commission, specification ARA-IV[1] and ICC-104 and 104-W tank cars, converted as follows, are authorized for use. Tanks must be tested to 75 pounds per square inch hydrostatic pressure and show no leakage with lagging removed. Bottom discharge outlet must be removed, the opening closed with a riveted plate, and a sump applied. Safety valves must be removed and replaced by two safety valves of the type and size used on ICC-105A100 or 105A100-W tank cars but set to open at 60 pounds per square inch instead of 75 pounds. The various approved dome fittings now required on ICC-105A100 or 105A100-W tank cars, must be installed in an approved manner to provide for the loading, unloading, gauging, sampling, and taking of temperature of contents without removing the manhole closure. Tank jacket must be stenciled immediately above the mark ARA-IV[1], ICC-104, or ICC-104-W with the words "For Ethylene Oxide Only."

(6) Spec. 105A300-W, 105A400-W, 105A500-W, or 105A600-W. Tank cars. Tanks must be restenciled 105A-100 or 105A-100-W and be equipped with safety valves of the type and size used on 105A100 and 105A100-W tank cars. See Note 1 of § 73.119 (f) (3). (See § 73.432 for shipping instructions.)

(b) Outgae must be sufficient to prevent tank car from becoming entirely filled with liquid at 105°F.

§ 73.125 **Alcohol.** (a) Alcohol must be packed as follows:

(1) In containers as prescribed in § 73.119 (a) and (b) of this part.

(2) Securely closed metal tanks of not exceeding 16 gallons capacity, made of metal not lighter than 20 gauge, United States standard, packed in strong outside wooden boxes, may be used for the transportation of natural history or laboratory specimens preserved in alcohol, when shipped by or for the United States Government.

(3) Spec. 12B. Because of the present emergency and until further order of the Commission, inside glass containers not over 1.21 gallons capacity each are authorized when only one inside container is packed in each outside container.

(4) Because of the present emergency and until further order of the Commission, existing tank cars complying with spec. 103, 103W, ARA-III[1], AAR 203[1], or AAR-203W[1], previously used for the transportation of wine, are authorized when stenciled "Alcohol Only" and equipped with safety valves of the type required on spec. 103 tank cars.

(5) Spec. 6J. Steel barrels or drums having inside spec. 28 polyethylene drum. Gross weight restriction indicated by the gross weight embossment in the steel barrel or drum shall be waived.

§ 73.126 **Nickel carbonyl.** (a) Nickel carbonyl must be packed in specification cylinders as prescribed for any compressed gas, except acetylene.

(b) Nickel carbonyl must not be offered for transportation by rail express.

§ 73.127 **Nitrocellulose or collodion cotton, fibrous, or nitro-starch, wet; colloided nitrocellulose, granular or flake, and lacquer base or lacquer chips, wet.** (a) Nitrocellulose or collodion cotton, fibrous, or nitrostarch, wet with alcohol or a solvent, must contain at least 30 percent by weight of alcohol or a solvent with flash point not lower than 30°F., colloided nitrocellulose, granular or flake, and laquer base or lacquer chips, wet with alcohol or a solvent, must contain at least 20 percent by weight of alcohol or a solvent with flash point not lower than 30°F.; must be packed in specification containers as follows:

(1) Containers, except cargo tanks or tank cars, as prescribed in § 73.119.

(2) Spec. 6A, 6B, 6C, or6J. Metal barrels or drums not over 55 gallons capacity. Spec. 6J drums must have removable heads of 14 gauge metal or 16 gauge metal with one or more corrugations near the periphery and heads must have a minimum convexity of ⅜ inch; each drum must have three rolled or swedged-in hoops, one of which shall be in the body near the curl.

(3) Spec. 42F. Aluminum barrels or drums. Authorized only nitrocellulose or collodion cotton, fibrous, wet, or colloided nitrocellulose, granular or flake, wet.

(4) Spec. 37A or 37B. Metal barrels or drums.

(b) Gross weight of any container must not exceed 450 pounds.

§ 73.128 **Paints and related materials.** (a) Paint, enamel, lacquer, stain, shellac, varnish, aluminum bronze, gold, wood filler, liquid, and lacquer base liquid, and thinning, reducing and removing compounds therefor, and driers, liquid, therefor must be packed in specification containers as follows:

(1) As prescribed in § 73.119 of this part, according to flash point, pressure, or viscosity.

(2) Spec. 37A or 37B. Metal drums (single-trip) not over 5 gallons capacity with welded side seams, irrespective of flash point or viscosity. Because of the present emergency and until further order of the Commission, spec. 37A or 37B metal drums of 8½ gallons capacity, with welded side seams and made of 24 gauge metal, are authorized provided flash point of material shipped is above 20°F.

(b) Paint, enamel, lacquer, stain, shellac, varnish, aluminum, bronze, gold, wood filler, liquid and lacquer base liquid, and thinning, reducing and removing compounds therefor, and driers, liquid, therefor, with flash point above 20° F., may in addition to containers prescribed in paragraph (a) of this section, be shipped in specification containers as follows:

(1) Spec. 10C. Wooden barrels or kegs.

(c) Paint, enamel, lacquer, stain, shellac, varnish, aluminum, bronze, gold, wood filler, liquid, and lacquer base liquid, and thinning, reducing and removing compounds therefor, and driers, liquid, therefore, in glass or earthenware containers of not over 1 quart capacity each, or metal containers of not over 5 gallons capacity each, packed in strong outside containers are exempt from specification packaging, marking, and labeling requirements when offered for transportation by rail freight, highway, or water except when offered for transportation by carrier by water, name of contents must be marked on outside container. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations. When offered for transportation by rail express, such shipments are exempt from specification packaging, marking, and labeling requirements, except that packages having inside containers of over 1 quart capacity each must be marked with name of contents and bear the red label as prescribed in § 73 405. When fiberboard box is used for such shipments by rail freight, rail express, highway, or water, gross weight must not exceed 65 pounds.

(1) Because of the present emergency and until further order of the Commission, paint, varnish and lacquer may be shipped under the conditions prescribed in paragraph (c) of this section, in containers not exceeding 1 gallon capacity with fiberboard bodies and metal tops and bottoms made leakproof in lieu of glass, earthenware, or metal containers as specified.

§ 73.129 **Polishes, metal, stove, furniture and wood, liquid.** (a) Polishes, metal, stove, furniture and wood, liquid, must be packed in specification containers as follows:

(1) As prescribed in § 73.119 of this part, according to flash point, pressure, or viscosity.

(2) Spec. 37A or 37B. Metal drums (single-trip) not over 5 gallons capacity with welded side seams, irrespective of flash point or viscosity.

(b) Polishes, metal, stove, fruniture and wood, liquid, in glass or earthenware containers of not over 1 quart capacity each, or metal containers not over 5 gallons capacity each, packed in strong outside containers not over 5 gallons capacity each, packed in strong outside containers are exempt from specification packaging, marking, and labeling requirements, except that marking name of contents on outside container is required for shipments via carried by water. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 or the I.C.C. Motor Carrier Safety Regulations. These exemptions do not apply to shipments offered for transportation by rail express. (See § 73.118 (b) for rail express exemptions).

§ 73.130 **Refrigerating machines.** (a) Refrigerating machines assembled for shipment and containing not over 15 pounds of a flammable liquid for their operation are exempt from specfication packaging, marking, and labeling requirements, except that marking name of contents on outside container is required for shipments via carrier by water. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

§ 73.131 **Road asphalt, or tar, liquid.** (a) Road asphalt or tar, liquid, must be packed in specification containers as follows:

(1) As prescribed in § 73.119 of this part, according to flash point, pressure, or viscosity.

(2) Spec. 10C. Wooden barrels or kegs, authorized only for material with flash point above 20°F.

§ 73.132 **Container cement, linoleum cement, pyroxylin cement, rubber cement, tile cement, wallboard cement, and coating solution.** (a) Container cement, linoleum cement, pyroxylin cement, rubber cement, tile cement, wallboard cement, and coating solution must be packed in specfication containers as follows:

(1) As prescribed in § 73.119, irrespective of flash point or viscosity, except that spec. 10A or 10B wooden barrels and kegs, must not be used.

NOTE 1: Because of the present emergency and until further order of the Commission, rubber cement containing no carbon bisulfide may be shipped in specfication 10A, wooden barrels or kegs.

§ 73.133 **Spirits of nitroglycerin.** (a) Spirits of nitroglycerin must consist of not over 10 percent by weight of nitroglycerin in ethyl alcohol. Solutions of nitroglycerin must consist of not over 10 percent by weight of nitroglycerin in acetone. They must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes lined with paraffined paper, spec. 2L, and with metal inside containers, securely closed with rubber stoppers tied in place. The inside containers must be entirely surrounded by at least 2 inches of dry, fine sawdust or kieselguhr. There must be not over 6 quarts of the mixture in each outside container.

NOTE 1: Because of the present emergency and until further order of the Commission, spirits of nitroglycerin, consisting of not over 10 percent by weight of nitroglycerin in ethyl alcohol, may be shipped in glass bottles not over 2 quarts capacity, securely closed with rubber stoppers tied in place. Each inside container must be entirely surrounded by at least 2 inches of dry fine sawdust or kieselguhr. There must be not over 8 quarts of the mixture in each outside container.

(b) Spirits of nitroglycerin consisting of not over 1 percent by weight of nitrtoglycerin in ethyl alcohol, in addition to containers specified in paragraph (a) (1) of this section, may be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes, with glass inside containers not over 1 quart capacity each, cushioned by at least 2 inches of dry, fine sawdust or kieselguhr.

§ 73.134 **Aluminum triethyl, aluminum trimethyl, pyroforic fuel, or zinc ethyl.** (a) Aluminum triethyl, aluminum trimethyl, pyroforic fuel, or zinc ethyl must be shipped in cylinders as prescribed for any compressed gas, except acetylene, or in devices or apparatus of a type approved by the Bureau of Explosives.

(b) Aluminum triethyl, aluminum trimethyl, pyroforic fuel, or zinc ethyl must not be offered for transportation by rail express.

§ 73.135 **Dimethyl dichlorosilane, ethyl dichlorosilane, ethyl trichlorosilane, methyl trichlorosilane, trimethyl chlorosilane, and vinyl trichlorosilane.** (a) Dimethyl dichlorosilane, ethyl dichlorosilane, ethyl trichlorosilane, methyl trichlorosilane, trimethyl chlorosilane, and vinyl trichlorosilane must be packed in specification containers as follows:

(1) Spec. 15A or 16B. Wooden boxes with glass containers not over 1 gallon capacity each securely closed and cushioned with incombustible absorbent material.

(2) Spec. 17H or 37A. Metal drums (single-trip) with glass inside containers not over 1 gallon capacity each securely closed and cushioned with incombustible absorbent material.

(3) Spec. 5A. Metal drums not over 55 gallons capacity.

(4) Spec. 5F. Metal drums not over 11 gallons capacity.

(5) Spec. 5, 5B, 5C, and 17E (single-trip). Metal drums. These containers not authorized for shipments by rail express.

(6) Specification cylinders as prescribed for any compressed gas, except acetylene.

(7) Spec 103 or 103W. Tank cars, without bottom discharge outlet.

(8) Spec. 105A100, 105A100-W or 105A300-W. Tank cars.

(9) Spec. MC 300 or MC 303. Tank motor vehicles.

§ 73.136 **Methyl dichlorosilane and trichlorosilane.** (a) Methyl dichlorosilane and trichlorosilane must be packed in specification containers as follows:

(1) Spec. 15A or 16B. Wooden boxes with glass inside containers not over 1 quart capacity each securely closed and cushioned with incombustible absorbent material.

(2) Spec. 17 H or 37A. Metal drums (single-trip) with glass inside containers not over 1 quart capacity each securely closed and cushioned with incombustible absorbent material.

(3) Spec. 5A. Metal drums not over 55 gallons capacity. This container not authorized for shipment by rail express.

(4) Spec. 5F. Metal drums not over 11 gallons capacity. This container not authorized for shipment by rail express.

(5) Specification cylinders as prescribed for any compressed gas, except acetylene.

(6) Spec. 103 or 103W. Tank cars, without bottom discharge outlet.

(7) Spec. 105A100, 105A100-W or 105A300-W. Tank cars.

§ 73.137 **Lithium aluminum hydride, ethereal.** (a) Lithium aluminum hydride, ethereal, must be packed in specification containers as follows:

(1) Spec. 15A. Wooden boxes with inside glass or earthenware containers not over 1 quart each enclosed in air-tight metal cans and cushioned with sufficient incombustible cushioning material to completely absorb contents in event of breakage.

(2) Spec. 6A, 6B, 6C, or 17H (single-trip). Metal barrels or drums with not more than one inside glass container not exceeding 2 gallons capacity. The inside container must be completely cushioned in sufficient incombustible cushioning material to completely absorb the contents in event of breakage.

(3) Specification cylinders as prescribed for any compressed gas, except acetylene. Valves or fittings must be protected from injury by a cap or equally efficient device.

§ 73.138 **Pentaborane.** (a) Pentaborane must be packed in specification cylinders as prescribed for any compressed gas, except acetylene. Cylinders must be protected with valve protection cap or must be packed in strong wooden boxes and blocked therein so as to protect the valves from injury under conditions normally incident to transportation. Cylinders not exceeding 2 inches in diameter nor 6 inches in length, excluding the length of the valve, may also be packed in strong solid fiberboard boxes, having no outside dimension less than 4 inches, completely filled with layers of strong corrugated fiberboard, the center of which shall be cut out to fit the cylinder valve, and otherwise so designed that neither the cylinder nor the valve will be in contact with any wall of the box under conditions normally incident to transportation.

(b) Pentaborane must not be offered for transportation by rail express.

§ 73.139 **Ethylene imine, inhibited.** (a) Ethylene imine must be inhibited and must be packed in specification containers as follows:

(1) Spec. 15A or 15B. Wooden boxes, with inside containers which must be securely sealed glass ampules or glass bottles, contents not over 16 fluid ounces or 1 pound each, in tightly closed metal cans. If more than one ampule or bottle is packed in a metal can, ampules or bottles must be separated by fiberboard partitions. Ampules or bottles must be cushioned in vermiculite or equally efficient incombustible cushioning material in quantity sufficient to completely absorb contents in event of breakage. Not more than 5 pints of liquid may be packed in any outside wooden box.

§ 73.140 **Zirconium, metallic solutions, or mixtures thereof, liquid.** (a) Zirconium, metallic, solutions, or mixtures thereof, liquid, must be packed in specification containers as follows:

(1) Spec. 15A, 15B, or 15C Wooden boxes with inside metal containers. Each inside container shall not contain more than 20 individual glass or porcelain jars, not exceeding 2-ounce capacity each, securely closed and completely cushioned in incombustible cushioning material in sufficient quantity to completely absorb the contents.

§ 73.141 **Amyl mercaptan, butyl mercaptan, ethyl mercaptan, isopropyl mercaptan, propyl mercaptan, and aliphatic mercaptan mixtures.** (a) Amyl mercaptan, butyl mercaptan, ethyl mercaptan, isopropyl mercaptan, propyl mercaptan, and aliphatic mercaptan mixtures must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with securely closed inside metal containers not over 5 gallons capacity each; or in tightly closed glass bottles not exceeding 1 quart capacity each, securely cushioned in sufficient qauntity of absorbent material to completely absorb the contents in event of leakage.

(2) Spec. 12B. Fiberboard boxes with securely closed inside metal containers not over 1 gallon capacity each; or in tightly closed glass bottles not exceeding 1 quart capacity each, securely cushioned in sufficient quantity of absorbent material to completely absorb the contents in event of leakage.

(3) Spec. 5, 5A, 5B, or 5C. Metal barrels or drums, with not more than one opening not exceeding 2.3 inches in diameter and not more than one vent opening not exceeding 1 inch in diameter. Gaskets are required and must be not less than 3/32 inch thick and of resilient material such as polyethylene, neoprene, or equally efficient material.

(4) Spec. 17C. Metal drums, (single-trip), with not more than one opening not exceeding 2.3 inches in diameter and not more than one vent opening not exceeding 1 inch in diameter Gaskets are required and must be not less than 3/32 inch thick and of resilient material such as polyethylene, neoprene, or equally efficient material.

(5) Spec. 17E. Metal drums (single-trip), not over 5 gallons capacity, without opening except bung hole not exceeding 2.3 inches in diameter. Gaskets are required and must be not less than 3/32 inch thick and of resilient material such as polyethylene, neoprene, or equally efficient material. (See also paragraph (a) (6) of this section.)

(6) Spec. 17E. Metal drums (single-trip), not over 55 gallons capacity, with not more than one opening not exceeding 2.3 inches in diameter and not more than one vent opening not exceeding 1 inch in diameter. Gaskets are required and must be not less than 3/32 inch thick and of resilient material such as polyethylene, neoprene, or equally efficient material. Authorized only for mercaptans having flash point above 20°F.

(7) Spec. 105A300-W, 105A400-W, 105A500-W, or 105A600-W. Tank cars.

(8) Spec. MC 330. Tank motor vehicles.

§ 73.143 **Methylchloromethyl ether, anhydrous.** (a) Methylchloromethyl ether, anhydrous, must be packed in specification containers as follows:

(1) Spec. 5K. Nickel barrels or drums.

(2) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside containers which must be glass or earthenware, not over 1 gallon capacity each, except that inside containers up to 3 gallons each are authorized when only one inside container is packed in each outside container.

(b) Methylchloromethyl ether, anhydrous, must not be offered for transportation by rail express.

§ 73.144 **Inks.** (a) Inks must be packed in specification containers as follows:

(1) In containers as prescribed in § 73.119, according to flash point, pressure, or viscosity.

(2) Spec. 17C. Full removable head metal drums (single-trip).

§ 73.145 **Methylhydrazine and uns-dimethylhydrazine.** (a) Methylhydrazine and uns-dimethylhydrazine must be packed in specification containers as follows:

(1) Spec. 1D. Boxed glass carboys.

(2) Spec 15A, 15B, or 15C. Wooden boxes with inside containers which must consist of glass bottles not exceeding 1-gallon capacity each, cushioned by means of vermiculite within tin cans which shall be tightly closed, or containers not over 2 quarts capacity each made of aluminum not less than 0.04 inch thick. Closures and gaskets must be of material which will not react dangerously with or be decomposed by contact with the contents.

(3) Spec. 5, 5A, or 5C; or 17E (single-trip). Metal barrels or drums which shall be of type 304 or 347 stainless steel, with openings not exceeding 2.3 inches in diameter.

(4) Spec. 17C, metal barrels or drums (single-trip) with openings not exceeding 2.3 inches in diameter. Authorized only for unsymmetrical dimethylhydrazine.

(5) Spec. 42B. Aluminum drums. Authorized only for unsymmetrical dimethylhydrazine.

§ 73.146. **Heaters for refrigerator cars, liquid fuel type.** (a) Heaters of the liquid fuel type for refrigerator cars, containing flammable liquid fuel, may be shipped in carload or truckload lots provided each heater shall have been inspected to see that flame has been extinguished, that there is no leakage of fuel, and that controls are in the "off" position Heaters shall be loaded and braced so as to prevent falling, tipping, or mechanical damage under normal conditions incident to transportation.

(b) Heaters of the liquid fuel type for refrigerator cars must have their fuel tanks completely drained if offered for transportation or transported in less-than-carload or less-than-truckload lots.

§ 73.147 **Methyl vinyl ketone, inhibited.** (a) Methyl vinyl ketone must be inhibited and must be packed in specification containers as follows:

(1) As prescribed in § 73.119 (a) or (b).

(b) Methyl vinyl ketone, inhibited, in glass or metal inside containers having not over 4 fluid ounces each and not more than one inside container securely and efficiently cushioned in strong outside fiberboard or wooden boxes, is exempt from specification packaging, marking, and labeling requirements except that marking name of contents on outside container is required for shipments via carrier by water. Shipments for transportation by highway carriers are exempt also from Part 77, except § 77.817, and Part 197.

SUBPART D—FLAMMABLE SOLIDS AND OXIDIZING MATERIALS; DEFINITION AND PREPARATION

§ 73.150 **Flammable solid; definition.** (a) A flammable solid for the purpose of Parts 71-78 is a solid substance other than one classified as an explosive, which is liable, under conditions incident to transportation, to cause fires through friction, through absorption of moisture, through spontaneous chemical changes, or as a result of retained heat from the manufacturing or processing.

§ 73.151 **Oxidizing material; definition.** (a) An oxidizing material for the purpose of Parts 71-78 is a substance such as a chlorate, permanganate, peroxide, or a nitrate, that yields oxygen readily to stimulate the combustion of organic matter.

§ 73.152 **Packing.** (a) Flammable solids or oxidizing materials must not be packed in the same outside container with corrosive liquids unless the corrosive liquids are in bottles, cushioned by incombustible absorbent material, in tightly closed metal containers.

NOTE 1: Oxidizing or other materials in quantity not exceeding 4 ounces, in securely closed metal cans, packed in the same compartment with other securely packed materials necessary for a complete fumigant, are acceptable for transportation.

(b) Closing and cushioning. All containers must be tightly and securely closed Inside containers must be cushioned as prescribed or in any case when necessary to prevent breakage or leakage.

§ 73.153 **Exemptions for flammable solids and oxidizing materials.** (a) Flammable solids and oxidizing materials, except those as enumerated in paragraph (c) of this section, in inside containers not over 1 pound net weight each, in outside containers not exceeding 25 pounds net weight each are, unless otherwise provided, exempt from specification packaging, marking, and labeling requirements, except that marking name of contents on outside container is required for shipments via carrier by water. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77,817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations. (See paragraph (c) of this section for articles not exempted, § 73.182 for exemptions for nitrates, and paragraph (b) of this section for exemption for organic peroxides.)

(b) Liquid or solid organic peroxides (see § 73.244 (a)), except acetyl benzoyl peroxide, solid, and benzoyl peroxide in strong outside containers having not over 1 pint or 1 pound net weight of the material in any one such package, having inside containers securely packed and cushioned with incombustible cushioning are, unless otherwise provided, exempt from specification packaging, marking, and labeling requirements, except that marking name of contents on outside container is required for shipments via carrier by water. Shipments for transportation by highway carriers are exmept also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

(c) The following articles in any quantity are not exempt under the provisions of paragraphs (a) or (b) of this section:

(1) Bags, nitrate of soda, empty and unwashed.

(2) Benzoyl peroxide.

(3) Burnt cotton.

(4) Calcium chlorite

(5) Calcium phosphide.

(6) Calcium resinate. (See § 73.166 of this part).

(7) Calcium resinate, fused.

(8) Isopropyl percarbonate, unstabilized.

(9) Charcoal, wood, screenings, except see § 73.162 (a) (4) of this part.

(10) Chlorobenzoyl peroxide (para).

(11) Coal, ground bituminous, sea coal and coal facings. (See § 73.165 of this part).

(12) Cobalt resinate, precipitated.

(13) Cotton waste, oily with more than 5 percent of vegetable or animal oil.

(14) Fiber burnt.

(15) Fibers or fabrics impregnated or saturated with animal or vegetable oils which are liable to spontaneous heating or combustion in transit.

(16) Fish scrap or fish meal containing less than 6 or more than 12 percent moisture (does not include wet acidulated fish scrap with moisture 40 to 55 percent) or which has not been sufficiently cooled after manufacture, or is liable to spontaneous heating in transit.

(17) Hair, wet.

(18) Iron sponge that has not been properly oxidized during manufacture.

(19) Lithium hydride.

(20) Lithium metal. (See § 73.206 (d) of this part)

(21) Lithium silicon.

(22) Matches, strike-anywhere.

(23) Motion-picture film (exposed), and motion-picture film scrap (nitrocellulose base).

(24) Motion-picture film old and worn out (nitrocellulose base).

(25) Paper stock, wet.

(26) Paper waste, wet.

(27) Tetranitromethane.

(28) Phosphoric anhydride.

(29) Phosphorus, amorphous, red.

(30) Phosphorus pentachloride.

(31) Phosphorus sesquisulfide.

(32) Phosphorus, white or yellow.

(33) Photographic film scrap.

(34) Picric acid, wet, exceeding 16 ounces.

(35) Potassium, metallic and potassium, metallic liquid alloy.

(36) Potassium peroxide.

(37) Pyroxylin plastic scrap.

(38) Rags, oily, with more than 5 percent of vegetable or animal oil.

(39) Rags, wet.

(40) Sodium amide.

(41) Sodium chlorite.

(42) Sodium hydride.

(43) Sodium, metallic and sodium, metallic liquid alloy.

(44) Sodium, metallic, dispersion in organic solvent.

(45) Sodium peroxide.

(46) Sodium picramate.

(47) Spent iron mass or spent iron sponge.

(48) Spent oxide.

(49) Tankage, garbage, tankage fertilizers, containing less than 8 percent moisture or having a temperature exceeding 100°F. when loaded.

(50) Tankage, rough ammoniate (tankages made from ammoniates such as leather scrap, horns, hoofs, hair, hair waste, felt waste), containing less than 7 percent moisture or having a temperature exceeding 100°F. when loaded.

(51) Textile waste, wet.

(52) Thorium metal, powdered. (See § 73.226 (b).)

(53) Titanium metal powder, wet.

(54) Urea nitrate, wet with not less than 10 per cent water, in excess of 16 ounces but less than 25 pounds.

(55) Wool waste, wet.

(56) X-ray film (exposed) and X-ray film scrap (nitrocellulose base)

(57) Zinc ammonium nitrite.

(58) Zirconium, metallic, dry, wet or sludge.

(59) Zirconium picramate.

(60) Acetyl benzoyl peroxide, solution.

(61) Calcium, metallic, crystalline.

(62) Nickel catalyst, finely divided, activated or spent.

(63) Lithium aluminum hydride.

(64) Sodium potassium alloys.

§ 73.154 **Flammable solids and oxidizing materials not specifically provided for.** (a) Flammable solids and oxidizing materials, as defined in §§ 73.150 and 73.151, other than those for which special packing requirements are prescribed, must be packed in specification containers of a design and constructed of materials that will not react dangerously with or be decomposed by the chemical packed therein, as follows:

(1) Spec. 6A, 6B or 6C. Metal barrels or drums.

(2) Spec. 17C, 17E, 17H, 37A, or 37B, metal drums (single-trip).

(3) Spec. 10A, 10B, or 10C. Wooden barrels or kegs.

(4) Spec 11A. Wooden barrels or kegs with inside containers or with suitable lining for bulk shipments.

(5) Spec. 11B. Wooden barrels or kegs with inside containers; or metal lined, spec. 2F, for bulk shipments.

(6) Spec. 12B. Fiberboard boxes with inside containers which must be metal cans; sliding-lid wooden boxes; fiber cans or boxes, spec. 2G, not over 5 pounds capacity each; or glass bottles not over 1 pound capacity each. Packages containing glass containers must not weigh over 65 pounds gross.

(7) Spec. 15A or 15B. Wooden boxes lined, spec. 2F or 2M.

(8) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside containers.

(9) Spec. 21A or 21B. Fiber drums.

(10) Spec 22A. Plywood drums.

(11) Spec. 22B. Plywood drums with inside metal drums, spec. 2F.

§ 73.155 **Bags, nitrate of soda, empty and unwashed.** (a) Bags, nitrate of soda, empty and unwashed, must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes.

(2) Spec. 10A, 10B, 10C, 11A, or 11B. Wooden barrels.

(b) Bags in carload and truckload lots loaded by consignor and to be unloaded by consignee may also be shipped loose or baled, provided the car or highway vehicle is lined with paper and doors of cars are properly stripped after sealing and provision is made on highway vehicle to prevnet entrance of sparks.

§ **73.156 Barium peroxide and calcium peroxide.** (a) Barium peroxide and calcium peroxide must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside glass containers not over 1 pound capacity each; or with inside glass containers not over 5 pounds capacity each cushioned with incombustible cushioning material; or with inside metal containers or lining, spec. 2F.

(2) Spec. 6A. Metal barrels or drums. Gross weight not to exceed 880 pounds.

(3) Spec. 6B or 6C. Metal barrels or drums with not more than 1400 pounds net weight in each container.

(4) Spec. 17E, 17H, 37A, or 37B. Metal drums (single-trip).

(5) Spec. 21A or 21B. Fiber drums.

§ 73.157 **Benzoyl peroxide, chlorobenzoyl peroxide (para), lauroyl peroxide, or succinic acid peroxide, wet.** (a) Benzoyl peroxide, chlorobenzoyl peroxide (para), lauroyl peroxide, and succinic acid peroxide, wet with at least 30 percent of water by weight must be packed in specification containers as follows:

(1) Spec. 15A, 15B, or 15C. Wooden boxes with inside metal containers or lining, spec. 2F or with inside paper bags lined with polyethylene at least 0.002 inch thick and not over 1-pound dry weight capacity each; or aluminum drums of at least 16 gauge United States standard, tightly sealed. Gross weight not over 200 pounds.

(2) Spec. 5, 5B, 6A, 6B, or 6C. Metal barrels or drums having liners of polyethylene or other suitable material. Not more than 4 vent holes of not to exceed ⅛" diameter may be provided in the drum near the top periphery. Gross weight not to exceed 350 pounds. Authorized only for benzoyl peroxide, wet.

§ **73.158 Benzoyl peroxide, dry, lauroyl peroxide, dry, chlorobenzoyl peroxide (para), dry, or succinic acid peroxide, dry.** (a) Benzoyl peroxide, dry lauroyl peroxide, dry, chlorobenzoyl peroxide (para), dry, or succinic acid peroxide, dry, may be shipped when packed in specification containers as follows:

(1) Spec. 15A or 15B. Wooden boxes, with inside fiber containers securely closed by taping or gluing, or inside securely closed paper bags lined with 0.002 inch thick, polyethylene, not over 1 pound capacity each. Except for lauroyl peroxide, dry, each inside container must be surrounded by asbestos or fire-resistant cushioning material which will protect contents with equal efficiency. Net weight in outside container must not exceed 50 pounds, except that for lauroyl peroxide, dry, net weight not over 100 pounds is authorized.

(2) Spec. 21A or 21B. Fiber drums, net weight not over 100 pounds, authorized only for lauroyl peroxide, dry.

(3) Spec. 12B. Fiberboard boxes, with inside fiber containers securely closed by taping or gluing, or inside securely closed paper bags lined with 0.002 inch thick polyethylene, not over 1 pound capacity each. Except for lauroyl peroxide, dry, each inside container must be surrounded by asbestos or fire-resistant cushioning material which will protect the contents with equal efficiency. Gross weight in spec. 12B65 boxes may be more than 65 but not more than 70 pounds provided net weight of contents does not exceed 50 pounds.

§ **73.159 Burnt cotton.** (a) "Burnt cotton" is cotton that has been on fire and from which the burnt portions have not been removed by repicking. It must not be offered for transportation until not less than 10 days have elapsed since the last evidence of fire in it. It must be marked and described on shipping orders and bills of lading as "Burnt Cotton, Yellow Label," and cars containing any quantity of it must be protected by the "Dangerous" placard.

(b) Burnt cotton must not be offered for transportation by rail express.

(c) When burnt cotton is picked and baled the separated cotton is not classed as a dangerous article and is not subject to Parts 71-78 and 197.

§ **73.160 Calcium chlorite and sodium chlorite.** (a) Calcium chlorite and sodium chlorite must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A or 19A. Wooden boxes with inside containers which must be glass or earthenware not over 2¼ pounds capacity each or metal not over 5 pounds capacity each.

(2) Spec. 6A, 6B, or 6C. Metal barrels or drums.

(3) Spec. 17E, 17H, 37A, or 37B. Metal drums (single-trip).

§ **73.161 Calcium phosphide.** (a) Calcium phosphide must be packed in specification containers as follows:

(1) Spec. 15A or 15B. Wooden boxes lined, spec. 2F, and with hermetically sealed inside containers.

(2) Spec. 6A, 6B, or 6C. Metal barrels or drums.

§ 73.162 Charcoal. (a) Charcoal as described in this paragraph is exempt from specification packaging, marking, and labeling requirements for transportation by rail freight, highway, or water except when for transportation by carrier by water, name of contents must be shown on outside container. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

(1) Charcoal, activated or carbon, activated.

(2) Charcoal made from pine wood and processed so that it is not liable to heat dangerously or cause fires in transportation.

(3) Charcoal briquettes made from wood charcoal with starch and water, or tar, for a binder, which have been screened and cooled to a temperature below 100°F., before being offered for transportation.

(4) Charcoal screenings made from "pinon" wood.

(5) Charcoal made from walnut shells, corn cobs, peach pits, and similar material, must be cooled and held not less than five days before shipment, and shipped in bags, barrels, or boxes.

(6) Charcoal, lump, made by the old kiln or pit method by which long air exposure is provided before shipment.

(7) Charcoal, wood, except charcoal screenings, when packed in boxes or barrels.

(8) Charcoal, wood, when in bags in less-than-carload or less-than-truckload shipments of not exceeding 2,000 pounds.

(9) When offered for transportation by rail express, charcoal, except charcoal briquettes, must be packed in barrels, bags, or boxes, and must bear the yellow label.

(b) Charcoal made in round retorts must be transferred to air-tight metal cans for cooling, and must be kept in these cans for 24 hours or more. The charcoal after removal from these cans should be aired by spreading on a floor to a depth not exceeding 1 foot. This air exposure must last not less than 44 hours. Not less than 72 hours should elaspe from the time the air exposure of the charcoal commences before a car loaded with it is closed for shipment, or before the lump charcoal is placed in paper bags.

(1) The charcoal during this airing period must be protected from the weather, and exposed to good circulation of air. When the charcoal is aired on the floor for only 24 hours and then placed in burlap bags, it must be kept in the bags 60 hours before shipment. If the charcoal is not aired on the floor for at least 24 hours, it must be kept in the burlap bags for at least 96 hours before loading for shipment.

(c) Charcoal made in ovens in slatted cars should be kept for two periods of 24 hours each in first and secondary air-tight cooling chambers respectively. After removing the charcoal from the secondary coolers it must be exposed to good air circulation but protected from the weather for a period of not less than 44 hours.

(1) Not less than 72 hours must elapse from the time the air exposure of the charcoal commences before a car loaded with it is closed for shipment, or before the lump charcoal is placed in paper bags.

(d) When fire occurs in charcoal during air exposure period, it should be extinguished with as little water as possible. Any charcoal wet in this way or otherwise must be dried, by again heating in the retorts or ovens, and cooled and aired in the usual way described in paragraphs (b) and (c) of this section, or the charcoal must be set aside and allowed to dry for not less than 30 days before shipment.

(e) Charcoal, lump, must be dry and free from screenings and brands.

(1) Shipments must be loaded into tight box cars, tight container cars, or into tight closed-top hopper cars, except that lump charcoal made from soft wood may be shipped in open or stock cars.

(2) When a chute is used in loading the car, the chute must contain a properly constructed screen which must be kept clean. This screen shall be not less than ¾ inch mesh. Forks with prongs not less than 1 inch apart must be used instead of shovels to handle the charcoal. The screenings which accumulate in the doorway of the car must be removed before loading the doorway. The car should be swept before loading, and a car which has contained lime must be thoroughly cleaned before loading with charcoal. The doors of the car must be closed tightly before the car is forwarded.

(3) Lump charcoal may be shipped in bags, barrels or boxes, or bulk in cars.

(4) Lump charcoal, dry and free from screenings and brands, may be shipped in bulk in motor vehicles. Vehicle must be swept before loading and if it contained lime it must be thoroughly cleaned.

(f) Charcoal screenings consist of small pieces of charcoal varying from about one-half inch in the maximum dimension to grains of dust These screenings are more liable to produce fires than other forms of charcoal. Charcoal screenings from wet charcoal or wet screenings or screenings which have been wet must not be offered for shipment unless they have been dried for not less than 12 hours in a retort or oven, and then subjected to not less than 10 days airing and cooling before shipment.

(1) Charcoal screenings must be stored in a dry place, in loosely piled bags, freely exposed to the air not less than 20 days after separation from the lump before shipment.

(2) Screenings from pine-wood charcoal must be stored as above described for not less than five days before shipment.

(3) Charcoal screenings must be packed in cotton or jute bags of not greater than 4 bushels capacity.

(4) Charcoal screenings, except screenings made from "pinon" wood, must not be offered for transportation by rail express.

(g) Charcoal ground, crushed, granulated, or pulverized is prepared from either lump charcoal or screenings.

(1) Lump charcoal used for the preparation of ground, crushed, granulated, or pulverized charcoal must be stored subject to ventilation, and protected from the weather for not less than 20 days after its removal from the coolers before milling; or the ground, crushed, granulated or pulverized charcoal must be stored in bags, subject to ventilation and protected from the weather for not less than 20 days before shipment. Lump charcoal made from pine wood must be stored as above described for not less than 5 days before milling. Ground, crushed, or granulated charcoal made by the "Stafford" process must be stored subject to ventilation and protected from the weather for not less than 7 days before shipment in lieu of the 20-days' storage otherwise prescribed.

(2) Charcoal screenings used for the preparation of ground, crushed, granulated, or pulverized charcoal must be stored in a dry place in loosely piled cotton or jute bags freely exposed to air for a period of not less than 20 days after separation from the lump charcoal, and before milling; or the ground, crushed, granulated, or pulverized charcoal must be stored in bags, subject to ventilation and protected from the weather for not less than 20 days before shipment. Charcoal screenings made from pine wood charcoal must be stored as above described not less than 5 days before milling.

(3) Ground, crushed, granulated, or pulverized charcoal must be packed in tight sift-proof wooden barrels or boxes containing not more than 4 bushels each; or in fiberboard boxes; or in unlined jute bags, or in strong unlined cotton bags, containing not more than 4 bushels each; or in paper-lined jute bags, or in paper bags, containing not more than 2½ bushels each. Whenever practicable, all boxes, barrels, or bags, after filling, should be allowed to remain open and freely exposed to the air, and protected from the weather for not less than 24 hours before being closed. Ground, crushed, granulated, or pulverized charcoal made from pine-wood charcoal should be so stored for not less than 72 hours before the packages are closed.

(h) Charcoal, screenings, or ground, crushed, granulated or pulverized charcoal, in bags, when loaded in cars for shipment by rail must be so loaded that the bags are laid horizontally in the car, and so piled that there will be spaces for efficient air circulation. These spaces must be not less than 4 inches wide. If the bags are not compactly filled and closed so as to avoid free space within, transverse wooden strips must be laid between the bags and extending the full width of the car; these strips should be approximately 2 feet apart vertically and longitudinally. The bags must not be piled closer than 6 inches from the top of the car, and no more than 26,000 pounds of screenings, ground, granulated, crushed, or pulverized charcoal, shall be loaded in a 36-foot, 6-inch car, 27,000 pounds in a 37-foot, 6-inch car, 28,000 pounds in a 38-foot, 6-inch car, 29,000 pounds in a 39-foot, 6-inch car, 36,000 pounds in a 40-foot, 6-inch car, and 40,000 pounds in a 50-foot, 6-inch car. A tight car must be used, and any loose material must be swept up and removed from the doorway of the car before completing the loading. On recommendation of the Bureau of Explosives, other methods of loading shown to be at least equally efficient in securing the necessary ventilation will be authorized.

(i) See § 77.838 for loading in motor vehicles.

(j) Charcoal burned in pits or kilns must be thoroughly cooled in the sealed kilns. After the kilns are opened, the charcoal must be allowed to stand in the open kiln or elsewhere exposed to the air for not less than 24 hours before loading in a freight car. Charcoal burned in kilns may be loaded in open cars or in box cars, but after loading in box cars, the cars must be allowed to stand not less than 24 hours with doors open before shipment.

(k) Screenings, or ground, crushed, granulated, or pulverized charcoal, from pit or kiln burned charcoal, are considered as non-hazardous, provided the screenings or the material from which the ground charcoal is made has been exposed to the air for not less than 5 days prior to shipment or grinding.

(l) Reburned charcoal must be cooled and exposed to fresh-air circulation for not less than five days after removal from the reburning furnaces and before being shipped or ground to produce ground or pulverized charcoal.

§ 73.163 **Chlorate of soda, chlorate of potash, and other chlorates.** (a) Chlorate of soda, chlorate of potash, and other chlorates must be packed in specification containers as follows:

(1) Spec. 6A, 6B, or 6C. Metal barrels or drums.

(2) Spec. 17E, 17H, 37A, or 37B. Metal drums (single-trip).

NOTE 1: Spec. 37A and 37B. Metal drums for export service, marked for an authorized gross weight of 160 pounds, must be at least 24 gauge metal throughout.

(3) Spec. 21A, 21B, 22A, or 22B Fiber or plywood drums with inside metal drums, spec. 2F.

(4) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes, or spec. 11A or 11B, wooden barrels or kegs, with tightly closed inside containers which must be of metal not over 10 pounds capacity each; or of glass not over 5 pounds each; or of fiber, spec. 2G, not over 6 pounds capacity each.

(5) Spec. 12B. Fiberboard boxes with inside metal cans not over 5 pounds capacity each, closed air tight and with not over 25 pounds of chlorate in the outside container.

(6) Chlorates wet with 10 percent or more of water are authorized for shipment in tank cars, spec. 103 or 103W, when equally distributed therein.

(7) Chlorate of soda is authorized for shipment in steel tank cars, or in tight sift-proof covered hopper cars. Cars must be thoroughly cleaned before loading.

§ 73.164 **Chromic acid.** (a) Chromic acid must be packed in specification containers as follows:

(1) Spec. 6A, 6B, or 6C. Metal barrels or drums.

(2) Spec 17E, 17H, 37A, or 37B. Metal drums (single-trip.)

(3) Spec. 15A or 15B. Wooden boxes, with inside glass bottles of not greater than 5 pounds capacity each, with closures securely fastened, each bottle individually packed in a tight metal container, and cushioned therein with incombustible mineral packing material; or with tightly closed metal inside containers, not over 10 pounds capacity each.

§ 73.165 **Coal, ground bituminous,** sea coal, coal facings. (a) Coal, ground bituminous, sea coal, coal facings, 90 percent of which will pass through a 100-mesh sieve, must be stored for at least six days after grinding, or if not so stored must be shipped in tight metal tank cars or in tight metal containers on container cars, or in permanently covered metal hopper cars, or in other tight metal containers, or in tight, metal-bodied, covered motor vehicles.

(b) Coal, ground bituminous, which has been dried by heating before grinding must be packed in hermetically sealed metal-lined wooden boxes or air-tight metal containers.

§ 73.166 **Cobalt resinate, precipitated, calcium resinate, and calcium resinate fused.** (a) Cobalt resinate, precipitated, calcium resinate, and calcium resinate fused, must be packed in specification containers as follows:

(1) Spec. 6A, 6B, or 6C. Metal barrels or drums.

(2) Spec. 17E, 17H, 37A, or 37B. Metal drums (single-trip).

(3) Spec. 15A or 15B. Wooden boxes with air-tight metal inside containers.

§ 73.167 **Cotton waste, oily.** (a) Cotton waste, oily with more than 5 percent of vegetable or animal oil must be packed as follows:

(1) In hermetically sealed metal-lined wooden boxes or air-tight metal containers.

(b) Such cotton waste must not be offered for transportation by carriers by rail express.

§ 73.168 **Lithium amide, powdered.** (a) Lithium amide, powdered, must be packed as follows:

(1) As prescribed in § 73.154 (a) (1), (2), (5), (8) and (11) of this part.

(2) Spec. 21A or 21B. Fiber drums with inside metal drum, spec. 2F.

§ 73.169 **Fiber, burnt.** (a) Fiber, burnt, must be packed in hermetically sealed metal-lined wooden boxes or air-tight metal containers.

(b) Such fiber must not be offered for transportation by rail express.

§ 73.170 **Fibers or fabrics impregnated, saturated or coated.** (a) Fibers or fabrics impregnated, saturated or coated with animal or vegetable oils, or organic substances, manufactured articles or processed materials which are liable to spontaneous heating or combustion in transit must be packed in hermetically sealed metal-lined wooden boxes or air-tight metal containers.

(b) Such materials, substances or articles must not be offered for transportation by rail express.

§ 73.171 **Fish scrap or fish meal.** (a) Fish scrap or fish meal containing less than 6 or more than 12 percent moisture (does not include wet acidulated fish scrap with moisture 40 to 55 percent), or which has not been sufficiently cooled after manufacture, or is liable to spontaneous heating in transit, must be packed in air-tight metal containers.

(b) Such fish scrap meal must not be offered for transportation by rail express.

§ 73.172 **Hair, wet.** (a) Hair, wet, must not be offered for transportation except in gondola cars or in open motor vehicles with metal bodies.

(b) Hair, wet, must not be offered for transportation by carriers by rail express.

§ 73.173 **Aluminum dross or magnesium dross.** (a) Aluminum dross or magnesium dross must not be shipped when hot or when containing moisture liable to cause heating or fire during transportation.

§ 73.174 **Iron sponge, spent oxide, spent iron mass, or spent iron sponge.** (a) Iron sponge that has not been properly oxidized during manufacture must be packed in hermetically sealed metal-lined wooden boxes or air-tight metal containers.

(b) Iron sponge not properly oxidized must not be offered for transportation by carriers by rail express.

(c) Spent oxide, spent iron mass, or spent iron sponge must be loaded in open steel cars or open highway vehicles with steel bodies. After exposure to air for a period of not less than 10 days, these articles may be offered for transportation by carrier by water in bulk in all-steel barges having open holds.

(d) Spent oxide, spent iron sponge, or spent iron mass must not be offered for transportation by carrier by rail express.

§ 73.175 **Lacquer base, or lacquer chips, dry.** (a) Lacquer base, or lacquer chips, dry, must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside metal containers, spec. 2F.

(2) Spec 6A, 6B, or 6C. Metal barrels or drums.

(3) Spec. 17E, 17H, 37A, or 37B. Metal drums (single-trip).

(4) Spec. 21A or 21B. Fiber drums.

§ 73.176 **Matches.** (a) Matches, when offered for transportation, must be of a type that will not ignite spontaneously when subjected for eight consecutive hours to a temperature of 200°F., in a properly conducted laboratory test. They must not exceed 3 inches in length, nor have a stick exceeding .015 square inch in cross-section area.

(b) For the purpose of Parts 71-78, matches are divided into two classes, viz.: (1) "strike-anywhere" and block matches and (2) "strike-on-box," book, and card matches Strike-anywhere and block matches are those for the ignition of which a prepared surface is not required. Strike-on-box, book, and card matches are those matches intended to be ignited on a prepared surface. Book and card matches may be fastened to a cover or folder, or the prepared match strips may not be so attached or covered.

(c) Packing. Matches, strike-anywhere, must not be packed in the same outside package with any other article, except that book, card and "strike-on-box" matches may be included when packed in separate inside containers.

(1) Matches, strike-anywhere, must be placed in individual containers consisting of an outer sliding shuck or cover and an inner holding tray or box. Individual containers consisting of a holding tray or box that telescopes over the box may be used. Boxes of suitable "hang-up" type may also be used, if approved by the Bureau of Explosives. All match boxes, covers, and trays must be made of cardboard, wood, or metal except that paper wrappings may be used for block or card matches.

(2) Individual containers must be wrapped in paper with not more than 12 boxes or individual containers in each paper-wrapped package. These packages must be secured on the ends and on the lapping side with glue, or similar satisfactory adhesive, making each 12 boxes or less of matches a serviceably wrapped and well-secured package.

(3) No individual container (not including card or block matches shall contain more than 700 strike-anywhere matches in any one container, box, or package. When more than 300 matches are packed in any individual container, box, or package, the matches must be arranged in two nearly equal portions with the heads of the two portions placed in opposite directions. All individual containers containing 350 or more matches must have placed over the matches a center holding or protecting strip made of cardboard, which can be scored or bent without fracture. This protecting strip shall be not less than 1¼ inches wide and shall be flanged down at least five-eighth inch on each end to hold the matches in position when the container is nested into the shuck or cover or withdrawn therefrom.

(d) Matches, unless exempted in paragraph (g) of this section, when offered for transportation by carriers by rail freight, highway, or water must be packed in specification containers as follows:

(1) Spec. 15A. Wooden boxes, with inside containers; not over 100 pounds each.

(2) Spec. 12B or 12C Fiberboard boxes with inside containers; not over 60 pounds each.

(3) The maximum number of match boxes contained in any one case shall be as follows:

Number of boxes	Nominal number of matches per box
½ gross	Not over 700.
1 gross	Not over 500.
2 gross	Not over 400.
3 gross	Not over 300.
5 gross	Not over 200.
12 gross	Not over 100.
20 gross	Over 50. Under 100.
25 gross	Not over 50.

(e) All individual containers of strike-anywhere matches when offered for transportation by rail express must be packed in specification containers as follows:

(1) Spec. 15A. Wooden boxes, lined, spec. 2F, or lined with asbestos board, lapped at all joints and all joints sealed air-tight. Gross weight not to exceed 50 pounds.

(2) Spec. 12C. Fiberboard boxes with paper-wrapped units of strike-anywhere matches covered with aluminum foil having joints hermetically sealed. Aluminum used for covering must be of such thickness that in the event matches become ignited fire will not communicate through the wrapped unit. Gross weight not to exceed 50 pounds.

(f) Marking. Outside containers of strike-anywhere matches shall show the name of the importer, distributor, or manufacturer and the brand or trademark under which such matches are manufactured and distributed to the trade. The name shall be printed in English.

(1) In addition, and separate therefrom, all outside containers shall have plainly marked thereon the words "STRIKE-ANYWHERE MATCHES."

(g) Matches, strike-on-box, book, and card packed in outside fiberboard or wooden boxes are not subject to the regulations in Parts 71-78 and 197.

(1) Matches, strike-on-box, book, and card may be packed in the sameoutside container with nonflammable articles when packed in outside fiberboard or wooden boxes. Such matches must be compactly packed in tightly closed inside containers or securely wrapped so as to prevent accidental ignition. When so packed, they are exempt from specification packaging, marking, and labeling requirements except when for transportation by carrier by water each outside container shall be marked "BOOK MATCHES," "STRIKE-ON-BOX MATCHES," or "CARD MATCHES," as the case may be Shipments for transportation by highway carriers are exmept also from Part 77, except section 77.817, and Part 197.

§ 73.177 **Motion-picture film and X-ray film.** (a) Motion-picture film and X-ray film (nitrocellulose base) (exposed) must be packed in specification containers as follows:

(1) Spec. 32A or 32B. Metal cases.

(2) Spec. 15A, 15B, or 15C. Wooden boxes with each reel in a tightly closed metal can, or strong cardboard or fiberboard box with cover held in place by adhesive tape or paper; gross weight not over 200 pounds.

(3) Spec. 12B. Fiberboard boxes complying with § 78.205-22 (a) (1); authorized for a single tightly closed inside metal can or strong cardboard or fiberboard box with cover held in place by adhesive tape or paper, not over 2,000 feet of film. Taped closure authorized.

(4) Spec. 12B. One-piece fiberboard boxes complying with § 78.205-22 (a) (2); authorized only when each film is in a tightly closed metal film-reel can or strong cardboard of fiberboard box with cover held in place by adhesive tape or paper containing not over 2,000 feet (ap-

proximately) of film; cans or boxes to be adequately braced in center of box by fiberboard, at least 175-pound test, extending full depth of box. Gross weight not over 65 pounds. Closing of box must be effected by coating entire contact surfaces of flaps with efficient adhesive; stitched closure not authorized Boxes that have been filled, shipped, and opened, are not authorized for reuse.

NOTE 1: Because of the present emergency and until further order of the Commission, containers authorized under § 73.180 (a) (2) of this part may be reused provided original shipment consisted of unexposed motion-picture film in carload or truckload quantities and that boxes were crated and had closing flaps held in place by paper tape.

(5) Spec. 32C. Trunks with each film in standard metal film-reel can or strong cardboard or fiberboard box with cover held in place by adhesive tape or paper. Trunks to contain no material other than films in cans or boxes and projecting apparatus. The apparatus, as packed, must not be capable of creating an electric current.

(6) Spec. 12B. Fiberboard boxes complying with § 78.205-27; authorized only for not more than two square inside metal cans containing not over 200 feet (approx.) of film each; gross weight not over 15 pounds. Taped closure authorized.

(b) Advertising matter must not be attached to outside of container. Slow burning (nonflammable) motion-picture film is exempt (§ 73.181 (a) (1) of this part), but when packed with flammable film all requirements must be complied with as if all contents were flammable film.

§ 73.178 **Motion-picture film, old and worn out (not scrap).** (a) Motion-picture film, old and worn out (not scrap), when shipped must be no longer exhibitable (with value only for reclamation of material), and must be packed in specification containers as follows: (See §§73.195 and 73.196 of this part for film scrap.)

(1) Spec. 15A. Wooden boxes lined, spec. 2F, or 2M; gross weight not over 450 pounds.

(2) Spec. 15A, 15B, 15C, or 19A. Wooden boxes with inside metal cans containing not over 1,000 feet of film; the cover of each can must fit tightly; gross weight not over 450 pounds.

(3) Spec. 32A or 32B. Metal boxes.

(4) Spec. 32D. Metal boxes. Net weight of film not over 250 pounds.

(5) Spec. 6A, 6B, 6C, or 6J; also 37A or 37B (single-trip containers). Metal barrels or drums.

(6) Spec 21A or 21B. Fiber drums.

§ 73.179 **Motion-picture film, toy.** (a) Motion-picture film, toy, of standard width (1⅜"), on metal reels, each containing 200 feet or less of film, when shipped must be inclosed in spark-proof metal cans packed in outside specification containers as follows:

(1) Spec. 15A, 15B, or 15C. Wooden boxes; maximum gross weight 250 pounds. (See § 73.181 (a) (3) of this part for toy motion-picture film pieces.)

§ 73.180 **Motion-picture film, and X-ray film, unexposed.** (a) Motion-picture film, and X-ray film, unexposed (nitrocellulose base), when offered for transportation by rail express or by carrier by water must bear the yellow label prescribed in § 73.406 of this part and must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, or 16A. Wooden boxes, provided it is in tight rolls of not over 3,000 feet; each roll must be in a tightly closed metal can with cover held in place by adhesive tape or paper, or each roll must be in a strong cardboard or fiberboard box with cover held in place by adhesive tape or paper. Gross weight not over 250 pounds.

(2) Spec. 12B. One-piece fiberboard boxes complying with § 78.205-22 (a) (2); authorized only when each film is in a tightly closed metal can or in a strong cardboard or fiberboard box with cover of can or box held in place by adhesive tape or paper and containing not over 2,000 feet (approx.) of film; interior packing required, of double-wall corrugated fiberboard pads at least 275-pound test, so arranged as to prevent can or box from touching the 6 faces of the outside box. Gross weight not over 75 pounds. Boxes that have been filled, shipped and opened are not authorized for reuse.

(b) Motion-picture film and X-ray film, unexposed (nitrocellulose base), when offered for transportation by rail freight and highway are exempt from specification packaging, marking other than name of contents, and labeling requirements. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

§ 73.181 **Motion-picture film; exemptions.** (a) Motion-picture film as follows is exempt from specification packaging, marking, and labeling requirements, except that marking name of contents on outside container is required for shipments via carrier by water. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

(1) Motion-picture film and X-ray film, slow-burning (nonflammable) and old and wornout motion-picture film, slow-burning (nonflammable).

(2) Motion-picture film scrap and X-ray film scrap, slow-burning (nonflammable).

(3) Motion-picture film, toy pieces of, exposed, of approximately ¾ inch by 1⅜ inches in size and not to exceed 1,000 such pieces inclosed in a tightly closed metal box and packed with other articles.

(4) Motion-picture outfits, toy, consisting of one projecting apparatus and not to exceed one roll of motion-picture film 12 feet or less in length, may be accepted without further restrictions, provided the film is packed in a securely closed metal can or box, this inclosed in a wooden box and packed with the projection apparatus in an outside fiberboard, corrugated strawboard, or wooden box.

§ 73.182 **Nitrates.** (a)

Aluminum nitrate
Ammonium nitrate
Ammonium nitrate (organic coating)
Ammonium nitrate—carbonate mixture
Ammonium nitrate—phosphate[1]
Ammonium nitrate fertilizer, containing 90% or more ammonium nitrate with no organic coating
Ammonium nitrate mixed fertilizer[1]
Barium nitrate
Calcium nitrate
Guanidine nitrate
Lead nitrate
Magnesium nitrate
Nitrates, n.o.s.
Nitrate of soda and potash
Nitro carbo nitrate
Potassium nitrate
Silver nitrate
Sodium nitrate, and
Strontium nitrate

when offered for transportation by rail freight, rail express, highway, or carriers by water shall be packed in containers as follows:

(1) Wooden or fiberboard boxes with glass, metal, or other strong inside containers; in metal or fiber drums; in kegs or barrels; or in strong metal cans. When so packed they are exempt from specification packaging, marking other than name of contents, and labeling requirements when for transportation by rail or highway. Ammonium nitrate-carbonate mixtures and ammonium nitrate mixed fertilizers so packed are exempt from labeling requirements when for transportation by water carrier. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

(b) Aluminum nitrate
Ammonium nitrate
Ammonium nitrate (organic coating)
Ammonium nitrate—carbonate mixture
Ammonium nitrate—phosphate[1]
Ammonium nitrate fertilizer, containing 90% or more ammonium nitrate with no organic coating
Ammonium nitrate mixed fertilizer[1]
Barium nitrate
Calcium nitrate
Guanidine nitrate
Nitrate of soda and potash
Potassium nitrate
Sodium nitrate, and
Strontium nitrate

when offered for transportation by rail freight, rail express, highway, or carriers by water, in addition to containers prescribed in paragraph (a) of this section, may be packed as follows:

(1) In bulk in tight closed freight cars. (See § 74.532(k) for loading requirements.)

(2) In bulk in sift proof closed or open type motor vehicles. (See § 77.838 (f) for loading requirements.)

(3) In bulk on cargo vessels subject to the Regulations for Explosives or Other Dangerous Articles on Board Vessels prescribed by the Commandant United States Coast Guard (46 CFR Part 146).

(4) In burlap bags not exceeding 200 pounds net weight, water-resistant, made tight against sifting, and made of not less than 7½ ounce burlap Ammonium nitrate-carbonate mixtures, calcium nitrate, potassium nitrate, sodium nitrate, nitrate of soda and potash, or strontium nitrate when so packed are exempt from labeling requirements and § 77.823. For water shipments see Regulations for Explosives or Other Dangerous Articles on Board Vessels prescribed by the Commandant United States Coast Guard (46 CFR Part 146). (See §§ 74 532 and 77.838 for loading requirements.)

(5) In multi-wall paper bags not exceeding 110 pounds net weight, of at least 4-ply construction including moisture-barrier ply, and made tight against sifting. Completed package, filled to weight with product and closed for shipment, must be capable of withstanding three 4-foot drops on face or back onto solid contrete without rupture. Ammonium nitrate-carbonate mixtures, calcium nitrate, potassium nitrate, sodium nitrate, nitrate of soda and potash, or strontium nitrate when so packed are exempt from labeling requirements and § 77.823. For water shipments see Regulations for Explosives or Other Dangerous Articles on Board Vessels prescribed by the Commandant United States Coast Guard (46 CFR Part 146). (See §§ 74.532 and 74.838 for loading requirements.)

§ 73.183 **Potassium nitrate mixed (fused) with sodium nitrite.** (a) Potassium nitrate mixed (fused) with sodium nitrite must be packed in containers as follows:

(1) In containers as prescribed in § 73.182 (a).

(2) Spec. 103-W. Tank cars specially designed, equipped and approved for this service without bottom discharge outlet and with heavier plate thicknesses than the minimum prescribed for cars built under this specification. For specification 103-W tank cars made of plates having the minimum prescribed thicknesses, internal reinforcement of the upper sheets of tank in the region of the dome and reinforcing plates attached to the bottom sheet of the tank which rests on bolsters is required, and these tanks must be equipped with baffle plates. Heater pipes must be of welded construction designed for a test pressure of 500 pounds per square inch. A 1-inch woven asbestos lining must be placed between bolster slabbing and bottom of tank to prevent heat transmission. Safety vents of the frangible disc type may be used and if used the frangible discs must be perforated with ⅛ inch hole. If safety valves are used, a vacuum relief valve must be installed on the dome. Tanks must be stenciled on both sides "FUSED POTASSIUM NITRATE AND SODIUM NITRITE ONLY."

§ 73.184 **Nitrocellulose or collodion cotton, wet, or nitrocellulose collided, granular, or flake, wet, or nitrostarch, wet, or nitroguanidine, wet.** (a) Nitrocellulose or collodion cotton, wet, or nitrocellulose, colloided, granular, or flake, wet, or nitrostarch, wet, or nitroguanidine, wet, must be uniformly wet with at least 20 pounds of water to 80 pounds of dry material and must be packed in specification containers as follows:

(1) Spec. 10A or 10B. Wooden barrels or kegs.

(2) Spec. 15A or 15B. Wooden boxes lined, spec. 2M.

(3) Spec. 6A, 6B, 6C, or 6J. Metal barrels or drums not over 55 gallons capacity. Spec 6J drums must have removable heads of 14 gauge metal or 16 gauge metal with one or more corrugations near the periphery and heads must have a minimum convexity of ⅜ inch; each drum must have three rolled or swedged-inhoops, one of which shall be in the body near the top curl.

(4) Spec. 37A or 37B. Metal drums (single-trip) not over 5 gallons capacity. Welded side seams required.

(5) Spec. 17E or 17H. Metal drums (single-trip).

(6) Sepc. 42F. Aluminum barrels or drums. Authorized only for nitrocellulose or collodion cotton, wet, or nitroecllulose, colloided, granular or flake, wet.

(b) Gross weight of any container must not exceed 450 pounds.

§ 73.185 Paper stock, wet. (a) Paper stock, wet, must be packed in hermetically sealed metal-lined wooden boxes or air-tight metal containers.

(b) Paper stock, wet, must not be offered for transportation by rail express

§ 73.186 **Paper waste, wet.** (a) Paper waste, wet, must be packed in hermetically sealed metal-lined wooden boxes or air-tight metal containers.

NOTE 1: Because of the present emergency and until further order of the Commission, paper waste, wet, free from oil or other foreign matter liable to cause spontaneous ignition may be shipped in bales.

(b) Paper waste, wet, must not be offered for transportation by rail express.

§ 73.187 **Peroxide of sodium.** (a) Peroxide of sodium must be packed in specification containers as follows:

(1) Spec. 11A, 11B, 15A, 15B, 15C, 16A, or 19A. Wooden barrels, kegs, or boxes, with inside containers which must be glass stoppered bottles, not to exceed 1 ounce net of material, each bottle inclosed in a metal can; or metal cans.

(2) Spec. 6A, 6B, or 6C. Metal barrels or drums.

(3) Spec. 17E, 17H, 37A, or 37B. Metal drums (single-trip).

§ 73.188 **Phosphorus anhydride.** (a) Phosphoric anhydride must be packed in specification containers as follows:

(1) Spec. 11A, 11B, 15A, 15B, or 15C. Wooden barrels, kegs, or boxes, with inside containers which must be tightly stoppered glass bottles not over 1 pound capacity each; or metal cans, not over 3 pounds capacity each, hermetically sealed (soldered) or closed with cork securely held in place by metal strap soldered in position. All inside containers must be cushioned with elastic incombustible packing material.

NOTE 1: Because of the present emergency and until further order of the Commission, metal cans not over 6 pounds capacity each are authorized.

(2) Spec. 6A, 6B, or 6C. Metal barrels or drums.

(3) Spec. 17E, 17H, 37A, or 37B. Metal drums (single-trip).

(4) Spec. 6K. Metal drums. Authorized only for carload or truckload shipments by rail freight or highway when loaded by the shipper and unloaded by the consignee or his duly authorized agent.

§ 73.189 **Phosphorus, amorphous red.** (a) Phosphorus, amorphous red, must be packed in specification containers as follows:

(1) Spec. 15A or 15B. Wooden boxes, with metal inside containers, with closures sealed air-tight and positively fastened

(2) Spec. 6A or 6B; also 37A or 37B (single-trip containers), for gross weight not over 160 pounds. Metal barrels or drums.

§ 73.190 **Phosphorus, white or yellow.** (a) Phosphorous, white or yellow, when offered for transportation by carriers by rail freight highway, or water may only be packed in water or dry.

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[1] Applies only to materials classed as dangerous under definition in § 73.150.

(b) When placed in water it must be packed in specification containers as follows:

(1) Spec. 15A or 15B. Wooden boxes with inside containers, which must be hermetically sealed (soldered) metal cans, inclosed in other hermetically sealed (soldered) metal cans; or hermetically sealed (soldered) metal cans, containing not over 1 pound each, inclosed in other, watertight, metal cans with screw-top closures; or hermetically sealed (soldered) metal cans, inclosed in hermetically sealed (soldered) metal box-lining, spec. 2F.

(2) Spec. 5A, 6A or 6B. Metal barrels or drums, not over 30 gallons capacity each.

(3) Spec. 103 or 103-W. Tank cars without bottom outlet discharge of lading and with approved dome fittings, external heater systems, and with insulation at least 4 inches in thickness, except that thickness of insulation may be reduced to 2 inches over external heater coils. Bottom washout nozzle of approved design may be applied. The material must be immersed in water and must be loaded at a temperature not exceeding 140°F. and then cooled until the water has a temperature not exceeding 105°F. before car is offered to carrier. The water must be loaded in the dome to not more than 50 percent of the capacity of the dome. After unloading, the tank must be filled to its entire capacity and the dome to not more than 50 percent of its capacity with water having a temperature not less than 105°F. and not over 140°F. and placarded with the caution placard prescribed in § 74.555, before the car is offered for return movement.

NOTE 1: Because of the present emergency and until further order of the Commission, Specification ARA-III[1] tank cars, converted as follows, are authorized for use: Without bottom discharge outlet, with insulation at least 2 inches in thickness, internal heater coils, at least one safety valve or frangible disc safety vent of approved design, and dome equipped for top unloading. Cars to be loaded and unloaded as prescribed in paragraph (b) (3) of this section. Cars to be stenciled immediately above the mark ARA-III[1] with the words "FOR PHOSPHORUS ONLY."

(4) Spec. MC 310 or MC 311, tank motor vehicles, without bottom outlet and with insulation at least 4 inches in thickness, except that 2 inches of insulation is authorized for tanks equipped with an exterior heating jacket. Interior heating coils are not authorized. The material must be immersed in water and must be loaded at a temperature not exceeding 140°F. and then cooled until the water has a temperature not exceeding 105°F. before being offered for transportation. After unloading, the tank must be filled to its entire capacity with water having a temperature not less than 105°F. and not over 140°F.

(c) Phosphorus, white or yellow, when offered for transportation by rail express must be packed in water in specification containers as follows (also authorized for transportation by carriers by rail freight, highway, or water):

(1) Spec. 15A or 15B. Wooden boxes with inside containers, which must be hermetically sealed (soldered) metal cans, containing not over 1 pound each, inclosed in other, water-tight, metal cans with screw-top closures, or with soldered closures.

(2) Samples of phosphorus, white or yellow, not to exceed 4 ounces each, placed in water in sealed metal cylinders or cans, inclosed in a wooden box, spec. 15A or 15B, may be transported only when consigned to the laboratory of the Internal Revenue Bureau or to the Hygienic Laboratory of the Public Health Service, Washington, D. C.

(d) Phosphorus, white or yellow, when dry must be cast solid and shipped in containers as follows:

(1) Spec. 6A, 6B, or 6C. Metal barrels or drums not over 30 gallons capacity each.

(2) In projectiles or bombs when shipped by, for, or to the Departments of the Army, Navy, and the Air Force of the United States Government, without bursting elements.

(e) Phosphorus, white or yellow, when dry must not be offered for transportation by rail express.

§ 73.191 Phosphorus pentachloride. (a) Phosphorus pentachloride must be packed in specification containers as follows:

(1) Spec. 11B, 15A, 15B, 15C, 16A, or 19A. Wooden barrels kegs, or boxes, with inside containers which must be glass or glazed earthenware containers, not over 25 pounds capacity each, cushioned with mineral packing; when inside containers are packed in the same outside container with other articles, they must be inclosed in tightly closed metal cans. Net weight of phosphorus pentachloride not over 50 pounds in each otuside container.

(2) Spec. 6A, 6B, or 6C; also 37A or 37B (single-trip containers). "Black iron" metal barrels or drums.

(3) Spec. 10A. Wooden barrels or kegs asphaltum lined.

(4) Spec. 28A. Metal-jacketed lead carboys.

§ 73.192 Picrate of ammonia (ammonium picrate), picric acid, trinitrobenzoic acid, and urea nitrate, wet. (a) Picrate of ammonia (ammonium picrate), picric acid, trinitrobenzoic acid, and urea nitrate, wet with not less than 10 percent water, in quantity not exceeding 16 ounces in one outside package, may be shipped as drugs, medicines, or chemicals, when in glass bottles securely stoppered, each bottle inclosed in a strong fiber carton properly cushioned in the otuside shipping case. No restrictions other than packing prescribed by this section are required when these materials are offered for transportation.

§ 73.193 Picric acid, trinitrobenzoic acid, or urea nitrate, wet. (a) Picric acid, trinitrobenzoic acid, or urea nitrate, wet with not less than 10 per cent water must be packed in specification containers as follows:

(1) Spec. 15A. Wooden box with inside containers of tightly closed glass or earthenware, cushioned, in outside container. The net weight in an outside package must not exceed 25 pounds dry weight. (See § 73.65 (e) for shipment of wet picric acid, wet trinitrobenzoic acid and wet urea nitrate in excess of 25 pounds, and § 73.192 for exemption up to 16 ounces.)

§ 73.194 Potassium permanganate. (a) Potassium permanganate must be packed in specification containers as follows:

(1) In containers as prescribed in § 73.154 of this part.

(2) Spec. 37A or 37B. Metal barrels or drums (single-trip).

§ 73.195 Pyroxylin plastic scrap, photographic film scrap, X-ray film scrap, motion-picture film scrap, or pieces of exposed or unexposed film. (a) Pyroxylin plastic scrap, photographic film, X-ray film scrap, motion-picture film scrap, or pieces of exposed or unexposed film, when offered for transportation by carrier by rail freight, highway, or water must be packed in specification containers as follows:

(1) Spec. 15A or 15B. Wooden boxes lined, spec. 2F or 2M; gross weight not over 450 pounds each.

(2) Spec. 6A, 6B, 6C, or 6J; also 17H, 37A, or 37B (single-trip containers). Metal barrels or drums.

(3) Spec. 11B. Wooden barrels or kegs with paper bags, spec. 2J as inside containers of the material; gross weight not over 375 pounds.

(4) Spec. 12B. Fiber boxes. Use of this container will be permitted because of the present emergency and until further order of the Commission.

(5) Spec. 21A or 21B. Fiber drums. Must be externally treated to provide protection against moisture.

(b) Pyroxylin plastic scrap, photographic film scrap, X-ray film scrap, motion picture film scrap, or pieces of exposed or unexposed film which show evidence of decomposition or instability or are liable to decompose or become unstable must be packed submerged in water in specification containers as follows:

(1) Spec. 6A, 6B, or 6C; or 17H (single-trip). Metal barrels or drums.

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[1] Use of existing tank cars authorized, but new construction not authorized

(2) Spec. 15A, 15B, or 15C. Wooden boxes with tightly closed inside metal containers.

§ 73.196 **Pyroxylin plastic scrap, photographic film scrap, X-ray film scrap, motion-picture film scrap, or pieces of exposed or unexposed film, shipments by rail express.** (a) Pyroxylin plastic scrap, photographic film scrap, X-ray film scrap, motion-picture film scrap, or pieces of exposed or unexposed film, except samples for laboratory examination, must not be offered for transportation by rail express.

(b) Samples for laboratory examination when offered for transportation by rail express must be packed in specification containers as follows:

(1) Spec. 15A, 15B, or 15C. Wooden boxes with inside metal container, hermetically sealed by soldering or with tape. Net weight not over 25 pounds; shipments must be marked, "Sample of (name of article) for laboratory examination."

§ 73.197 Pyroxylin plastics, in sheets, rolls, rods, or tubes. (a) Pyroxylin plastics, in sheets, rolls, rods, or tubes containing nitrocellulose is not subject to Parts 71-78 and 197 when offered for transportation by carriers by rail freight or highway but when offered for transportation by carriers by rail express or water must be packed in specification containers as follows and must bear the yellow label:

(1) Spec. 15A, 15B, or 19A. Wooden boxes.

(2) Spec. 12B. Fiberboard boxes. Special boxes §§ 78.205-20 and 78.205-21 authorized only for pyroxylin in sheets, rods or tubes.

(3) Sheets, rolled, in fiber drums, spec. 21A or 21B, having 2 straps applied lengthwise and 1 or more circumferentially; straps at least ½ by 0.02 inch steel.

(4) Sheets, rolled, not over 15 pounds net weight in fiber tubes lined throughout with singlefaced corrugated fiberboard at least 0.2 inch thick and securely closed; tube material at least 0.115 inch thick for side walls and 0.05 inch thick for ends with strength, Mullen or Cady test, at least 245 and 220 pounds respectively; metal ends for tubes acceptable when lined with fiber discs at least 0.05 inch thick.

(b) Pyroxylin plastics in manufactured articles or articles made therefrom is not subject to Parts 71-78 and 197.

§ 73.198 **Sodium hydride.** (a) Sodium hydride must be packed in specification containers as follows:

(1) In containers as prescribed in § 73.206 (a) (1) and (a) (2) of this part.

(2) Spec. 17H. Metal drums (single-trip).

(3) Spec. 37A or 37B. Metal drums (single-trip) with welded side seams and hermetically sealed closure made fast by positive pressure of the lid against a rubber gasket with edge of the lid crimped over the lip of the drum and a protective metal ring fastened around the crimped edge, packed in strong outside wooden boxes.

§ 73.199 **Rags, oily.** (a) Rags, oily, with more than 5 percent of vegetable or animal oil, must be packed in hermetically sealed metal-lined wooden boxes, or air-tight metal containers.

(b) Rags, oily, as described above, must not be offered for transportation by rail express.

§ 73.200 **Rags, wet.** (a) Rags, wet, must be packed in hermetically sealed metal-lined wooden boxes, or air-tight metal containers.

(b) Rags, wet, must not be offered for transportation by rail express.

§ 73.201 **Rubber scrap, rubber buffings, reclaimed rubber, or regenerated rubber.** (a) Rubber scrap, if ground, powdered, or pulverized, and the rubber content of which exceeds 45 percent, as determined by subtracting the sum of the percentage of ash and the percentage of acetone extract from 100; rubber buffings from any grade of rubber, irrespective of the percentage of rubber content; and reclaimed rubber or regenerated rubber, must be packed in specification containers as follows (see paragraph (b) of this section):

(1) Spec. 6A, 6B, or 6C. Metal barrels or drums.

(2) Spec. 15A. Wooden boxes lined, spec 2F, or 2M

(3) Spec. 10A. Wooden barrels or kegs.

(4) Spec. 12B. Fiberboard boxes.

(5) Spec. 21A or 21B. Fiber drums.

(6) Spec. 22A. Wooden drums.

(7) Tank cars tightly and securely closed.

(8) Spec. 36A, 36B, 36C, 44B, or 44E. Bags.

(b) Rubber scrap, reclaimed rubber, or regenerated rubber are not subject to Parts 71-78 and 197 if shipped in the following forms:

(1) Rubber scrap, not ground or ground with cord or fabric insertion, or ground without cord or fabric insertion the particles of which pass over a screen of not less than 5-mesh.

(2) Reclaimed rubber or regenerated rubber when in the form of dense homogeneous nonporous sheets or rolls, the sheets of thickness of ⅛ inch or greater, packed flat or in rolls, or in pelletized form if not less than ¼ inch in diameter, or ground, the particles of which pass over a screen of not less than 5-mesh, all properly cooled before shipment.

(3) Rubber scrap, reclaimed rubber, or regenerated rubber in any form when shipped in covered steel hopper cars, tank cars, or tank or hopper trucks.

§ 73.202 **Sodium and potassium, metallic liquid alloy.** (a) Sodium and potassium, metallic liquid alloy must be packed in specification containers as follows:

(1) Spec. 15A or 15B. Wooden boxes with inside metal containers of a type approved by the Bureau of Explosives cushioned with incombustible cushioning material. Each container must have been tested hydrostatically to a pressure of not less than 60 pounds per square inch. Closing devices must be protected from injury. Not more than 300 pounds of sodium or potassium liquid alloy may be shipped in one outside container.

(2) Spec. 5A, metal barrels or drums not exceeding 400 pounds capacity each, having protruding valves protected by a 12-gauge steel dome securely attached to the head of the drum. Shipments are authorized by rail freight in carload lots only and by motor vehicle in truckload lots only.

§ 73.203 **Tetranitromethane.** (a) Tetranitromethane must be packed in specification containers as follows:

(1) Spec. 15A or 15B. Wooden boxes, gross weight not exceeding 150 pounds, with inside containers which must be: glass bottles not more than 1 quart capacity each, with closures securely fastened and of a type not deteriorated by the contents, each bottle individually packed in a tight metal container and cushioned therein with absorbent incombustible material; or aluminum cans or polyethylene bottles, not more than 5 pounds capacity each, with opening not more than 1.25 inches diameter, fitted with securely fastened screw type closures and gaskets of material not deteriorated by contact with the contents, cushioned with not less than 2 inches of absorbent incombustible cushioning material between the inside containers and any part of the wooden box.

(2) Spec. 6A, 6B, or 6C. Metal barrels or drums, with inside stainless steel or aluminum drum (or drums) having no opening exceeding 2.5 inches diameter, openings to be securely closed by a screw type gasketed device, with gaskets of material not deteriorated by contact with the contents. The inside drum (or drums) must be cushioned with not less than 2 inches of absorbent incombustible cushioning material; inside drums shall be of not less than 20 gauge metal and shall be tested for leakage before packing in the outside drum.

§ 73.204 **Sodium hydrosulfite.** (a) Sodium hydrosulfite must be packed in specification containers as follows:

(1) Spec. 11A, 11B, 15A, 15B, 15C, 16A, or 19A. Wooden barrels, kegs, or boxes with inside glass bottles of capacity not exceeding 5 pounds each, or metal containers.

(2) Spec. 6A, 6B, or 6C Metal barrels or drums.

(3) Spec. 17E, 17H, or 37K. Metal drums (single-trip).

(4) Spec. 37A or 37B. Metal drums (single-trip). These containers are not authorized for transportation by carriers by water.

(5) Spec. 21A or 21B. Fiber drums with inside metal drums.

(6) Spec. 21A or 21B. Fiber drums, net weight not over 250 pounds; drums must have a metal foil (laminated between two sheets of kraft paper with thermoplastic adhesive) moisture and water barrier wound into the sidewall of the drum and located not more than 2 plies from the interior of drum but not to be wound as the first ply; a metal foil moisture and water barrier must also be present in the fiber or wood heading; exterior of drum sidewall must be protected with a water resistant coating; in addition to the tests prescribed by §§ 78.222-4 and 78.223-4, a drum having been given a 4-foot diagonal bottom chime drop must, after being emptied, withstand complete immersion of the bottom in 6 inches of water for 4 hours without leakage to the interior; drums must not be offered for transportation by carriers by water.

(7) Spec 22B. Plywood drums with inside metal drums.

NOTE 1: Because of the present emergency and until further order of the Commission, the use of inside metal drums will not be required but in lieu thereof the drum must be lined or otherwise treated so as to prevent the entrance of moisture in quantities sufficient to create a hazardous condition in transportation. Maximum loaded capacity 110 pounds net.

§ **73.205 Sodium picramate, wet.** (a) Sodium picramate must be wet with not less than 20 percent of water by weight and packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with well stoppered glass inside containers of not exceeding 1 quart capacity each, cushioned in the boxes.

(2) Spec. 10A or 10B. Wooden barrels, or kegs.

§ **73.206 Sodium or potassium, metallic, sodium amide, sodium potassium alloys, lithium metal, lithium silicon, lithium hydride, and lithium aluminum hydride.** (a) Sodium or potassium, metallic, sodium amide, sodium potassium alloys, lithium metal, lithium silicon, lithium hydride, and lithium aluminum hydride, must be packed in specification containers as follows:

(1) Spec. 15A or 15B. Wooden boxes with air-tight metal inside containers which must have closing device securely fastened by positive means (not friction). Inside metal cans with closures securely fastened, positive means not required, must not exceed 1-gallon capacity each for lithium aluminum hydride and must be cushioned in outside containers with sufficient incombustible packing material

(2) Spec. 5, 6A, 6B or 6C. Metal barrels or drums. Not authorized for lithium aluminum hydride.

(3) Spec. 17E, 17H, 37A, or 37B. Metal drums (single-trip). Authorized only for sodium which must be fused solid in the container.

(4) Spec. 37A or 37B. Metal drums (single-trip) not exceeding 6 gallons capacity each, with welded side seams and hermetically sealed closure or closure made fast by positive pressure of the lid against a rubber gasket with edge of the lid crimped over the lip of the drum and a protective metal ring fastened around the crimped edge, cushioned on all sides with incombustible packing material, packed in strong outside wooden boxes (see § 73.25). Not more than 4 inside metal drums shall be packed in one outside wooden box.

(5) Spec. 17C, metal drums (single-trip). Not authorized for lithium aluminum hydride.

(6) Spec. 17H or 37A. Metal drums (single-trip), with air-tight metal inside containers which must have closing device securely fastened by positive means (not friction). Inside metal containers must be cushioned on all sides by incombustible packing material. Authorized for lithium metal or lithium hydride only.

(b) Sodium or potassium, metallic, sodium amide, and lithium metal, immersed in neutral oil may also be shipped when packed in specification containers as follows:

(1) Spec. 15A or 15B. Wooden boxes with inside metal drums, spec. 37A or 37B (single-trip), having welded side seams, net weight not over 30 pounds, or with inside glass containers, each enclosed in a tin container.

(c) Sodium, metallic, may also be shipped when packed in specification containers as follows:

(1) Spec. 105A300-W. Tank cars, having exterior heater coils fusion welded to tank shell and properly stress-relieved, the material to be in molten condition when loaded into the tank and allowed to solidify before car is offered to the carrier.

(2) Spec. 17C, 17H, 37A, or 37B. Metal drums (single-trip) authorized for cylindrical blocks at least 2 inches in diameter and not less than 6 inches in length, or rectangular blocks not less than 6 inches in length and not less than 2 inches in any other dimension. Net weight not over 300 pounds for spec. 17C drums; not over 30 pounds for spec. 17H, 37A, or 37B drums.

(d) Lithium metal in cartridges, when packed and described as follows is exempt from specification packaging and labeling requirements:

(1) In inside hermetically sealed metal cartridges not exceeding 18 grams net weight each, packed in strong outside containers with net weight of lithium metal not exceeding one pound.

(e) Lithium metal in cartridges, containing more than 18 grams but not more than 120 grams of lithium, must be packed in specification containers as follows:

(1) Spec. 15A or 15B. Wooden boxes, not over 75 pounds gross weight, with air-tight inside copper cartridges which must be separated or securely cushioned therein. Each cartridge must have a minimum thickness of 0.02 inch.

§ **73.207 Sulfide of sodium or sulfide of potassium, fused or concentrated, when ground.** (a) Sulfide of sodium or sulfide of potassium, fused or concentrated, when ground, must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, or 16A. Wooden boxes with inside containers which must be glass bottles enclosed in tightly closed metal cans, or hermetically sealed (soldered) metal cans.

(2) Spec. 6A, 6B, or 6C. Metal barrels or drums.

(3) Spec. 12B. Fiberboard boxes, with inside containers which must be hermetically sealed (soldered) metal cans of not over 5 pounds capacity.

(b) When fused or concentrated, but not ground (may be chipped, flaked, or broken), may be shipped in specification containers as follows:

(1) Spec 15A, 15B, 15C, or 16A. Wooden boxes with inside bottles of not more than 5 pounds capacity each, or metal cans, with tight covers.

(2) Spec. 12B. Fiberboard with inside containers which must be metal cans of not over 5 pounds net weight each or glass bottles of not over 1 pound net weight each. Packages containing glass or earthenware containers must not weigh over 65 pounds gross.

(3) Spec. 17E, 17H, 37A, or 37B. Metal drums (single-trip).

(4) Spec. 6A, 6B, or 6C. Metal barrels or drums.

(5) Spec. 21A or 21B. Fiber drums which must be lined or coated, or otherwise treated so as to prevent the entrance of moisture in quantities sufficient to create a hazardous condition in transportation; drums to withstand two drops from height of 4 feet in same spot or

one 6-foot drop in place of drop test as provided in Spec. 21A or 21B; maximum loaded capacity 250 pounds net. Use of this container will be permitted because of the present emergency and until further order of the Commission.

(c) Sulfide of potassium, crystallized, is not subject to Parts 71-78 and 197.

(d) Sodium sulfide when shipped fused in one solid mass in a metal barrel or drum and sodium sulfide, crystallized, are not subject to Parts 71-78 and 197.

(e) Sodium sulfide containing 35 percent or more combined water by weight, fused or concentrated but not ground (may be chipped, flaked, or broken), when packed in steel barrels or drums that are equipped with moisture-tight closures, is not subject to Parts 71-78 and 197.

§ **73.208 Titanium metal powder, wet or dry.** (a) Titanium metal powder, wet. Titanium metal powder, wet, with not less than 20 percent water, must be packed in specification containers as follows:

(1) Spec. 15A or 15B. Wooden boxes with inside metal cans not exceeding 1 gallon each, tightly and securely closed, and not more than 12 such inside metal cans in one outside package; or not more than 1 inside metal can of not less than 22-gauge metal and not to exceed 10 gallons capacity, tightly and securely closed.

(b) Titanium metal powder, dry. Titanium metal powder, dry, must be packed in specification containers as follows:

(1) Spec. 15A or 15B. Wooden boxes with inside metal containers, tightly and securely closed by push-in covers, held in place by soldering at least four points, or in screw-cap metal cans. Inside containers must not exceed 10 pounds net each. Inside containers must be cushioned by incombustible material such as rock wool or asbestos wool. Gross weight of outside package must not exceed 75 pounds each.

(2) Spec. 17H or 37A Metal barrels or drums (single-trip) with inside metal drum of not less than 20-gauge metal and with closure secured by positive means. The inside container shall be completely surrounded by not less than 1 inch of incombustible cushioning material.

§ **73.209 Tankage, garbage, and tankage fertilizers.** (a) Tankage, garbage, and tankage fertilizers, containing less than 8 percent moisture or having a temperature exceeding 100°F. when loaded, must be packed in hermetically sealed metal-lined wooden boxes or air-tight metal containers.

(b) Such tankage, garbage, and tankage fertilizers, must not be offered for transportation by rail express.

§ **73.210 Tankages, rough ammoniate.** (a) Tankages, rough ammoniate (tankages made from ammoniates such as leather scrap, horns, hoofs, hair, hair waste, felt waste), containing less than 7 percent moisture or having a temperature exceeding 100°F. when loaded, must be packed in hermetically sealed metal-lined wooden boxes or air-tight metal containers.

(b) Tankages, rough ammoniate, must not be offered for transportation by rail express.

§ **73.211 Textile waste, wet.** (a) Textile waste, wet, must be packed in hermetically sealed metal-lined wooden boxes or air-tight metal containers.

(b) Textile waste, wet, must not be offered for transportation by rail express.

§ **73.212 Trinitrobenzene and trinitrotoluene, wet.** (a) Trinitrobenzene and trinitrotoluene, wet with not less than 10 percent water, in quantity not exceeding 16 ounces in one outside package, may be shipped as drugs, medicines or chemicals, when in glass bottles securely stoppered, each bottle inclosed in a strong fiber carton properly cushioned in the outside shipping case and are not subject to any other requirement of Parts 71-78 and 197.

§ **73.213 Wool waste, wet** (a) Wool waste, wet, must be packed hermetically sealed metal-lined wooden boxes or air-tight metal containers.

(b) Wool waste, wet, must not be offered for transportation by rail express.

§ **73.214 Zirconium metal powder or hafnium metal powder, wet or sludge.** (a) Zirconium metal powder or hafnium metal powder, wet or sludge, must be packed in specification containers as follows:

(1) Spec. 15A or 15B. Wooden boxes with inside metal cans, spec. 2A, of screw-cap type, or tightly and securely closed by push-incovers held in place by soldering or crimping at least at four points and not exceeding 10 pounds net weight each; or inside metal drums of not less than 26 gauge bodies and heads, with welded side seams and gasketed closure of positive type (not friction), and capacity not over 50 pounds net weight. Gross weight of outside containers must not exceed 150 pounds.

(2) Spec. 10A. Wooden kegs containing not to exceed 75 pounds net each.

§ **73.215 Zirconium or hafnium metal powder or sponge, dry.** (a) Zirconium or hafnium metal powder or sponge, dry, must be packed in specification containers as follows:

(1) Spec. 15A or 15B. Wooden boxes with inside metal containers, tightly and securely closed by push-in covers held in place by soldering or crimping at least at four points, or in screw-cap type metal cans. Inside containers must not exceed 10 pounds net each. Gross weight of outside packages must not exceed 75 pounds each.

(2) Spec. 12B. Fiberboard boxes with inside containers which must be securely closed glass bottles or metal containers not over 1 pound net weight each and enclosed in a securely closed metal can and sufficiently cushioned with incombustible material.

(3) Spec. 6A, 6B, or 6C. Metal barrels or drums not exceeding 30 gallons capacity. Authorized only for zirconium or hafnium metal sponge (not powder).

(4) Spec. 17H, 37A, or 37B Metal drums (single-trip) not exceeding 30 gallons capacity. Authorized only for zirconium or hafnium metal sponge (not powder).

(5) Zirconium or hafnium metal of particle size exceeding 20 mesh is not subject to these regulations.

§ **73.216 Zirconium picramate, wet.** (a) Zirconium picramate must be wet with not less than 20 percent of water by weight and packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with well stoppered glass inside containers of not exceeding 1 quart capacity each, cushioned in the boxes.

(2) Spec. 10A or 10B. Wooden barrels or kegs.

§ **73.217 Calcium hypochlorite compounds, dry and lithium hypochlorite compounds, dry.** (a) Calcium hypochlorite compounds, dry, containing more than 39 percent available chlorine, and lithium hypochlorite compounds, dry, containing more than 39 percent available chlorine must be packed in specification containers as follows:

(1) Spec. 6A, 6B, or 6C. Metal barrels or drums

(2) Spec. 17E, 17H, 37A, or 37B. Metal drums (single-trip).

(b) Strong outside wooden or fiberboard packages containing inside containers of glass or metal not over five pounds capacity each, except that metal inside containers not over seven and one-half pounds capacity each are authorized for material tablet form only, are exempt from specification packaging, marking, and labeling when offered for transportation by rail freight, rail express or highway. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations. When for transportation by water, strong wooden or fiberboard packages containing inside containers of metal not over five pounds capacity each are exempt from specification packaging only.

§ **73.218 Isopropyl percarbonate, unstabilized.** (a) Isopropyl percarbonate, unstabilized, must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes, or other equally efficient container when approved by the Bureau of Explosives, with glass, metal, or earthenware inside containers of not over 2 gallons capacity each which must be maintained at a temperature below 0°F. Shipments are authorized for transportation by private or contract carrier by motor vehicle only.

§ 73.219 **Potassium perchlorate.** (a) Potassium perchlorate must be packed as follows:

(1) As prescribed in § 73.154 (a) (1) to (11) of this part.

(2) In tight bags which will not permit sifting in transit.

§ 73.220 **Magnesium scrap (borings, clippings, shavings, sheets, or turnings).** (a) Magnesium scrap consisting of borings, shavings, or turnings, when shipped in carloads or truckloads, must be packed in closed metal barrels, wooden barrels, metal pails, or four-ply paper bags. In less-than-carload or less-than-truckload quantities it must be packed in closed metal drums, metal pails, or wooden barrels.

(b) Magnesium scrap consisting of clippings or scrap sheets may be shipped in bulk in carload or truckload quantities. Cars must be tight box cars or tightly closed steel covered gondola cars and trucks or trailers must have closed or completely covered bodies.

(c) Magnesium scrap consisting of clippings or scrap sheets in closed metal drums, wooden barrels, or wooden boxes is exempt from specification packaging, marking, and labeling requirements. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C C. Motor Carrier Safety Regulations.

§ 73.221 **Liquid peroxides other than acetyl peroxide solution, acetyl benzoyl peroxide solution, cumene hydroperoxide, dicumyl peroxide, hydrogen peroxide, peracetic acid, and teritary butylisopropyl benzene hydroperoxide.** (a) Liquid peroxides other than acetyl peroxide solution, acetyl benzoyl peroxide solution, cumene hydroperoxide, dicumyl peroxide, hydrogen peroxide, peracetic acid, and teritary butylisopropyl benzene hydroperoxide must be packed in specification containers as follows:

(1) Spec. 1A or 1D. Carboys, glass, boxed, capacity not over 5 gallons for spec. 1A, and 6.5 gallons for spec. 1D.

(2) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside containers which must be glass or earthenware, not over 1 gallon each, cushioned with incombustible packing material in sufficient quantity to absorb the contents of the inner container.

(3) Spec. 12B. Fiberboard boxes with inside containers which must be glass or earthenware not over 1 gallon each, cushioned with incombustible packing material in sufficient quantity to absorb the contents of the inner container. Not more than one 1-gallon inside container shall be packed in one outside fiberboard box.

(4) Spec 42B. Aluminum drums not over 15 gallons capacity. Authorized only for peroxides which will not react dangerously with the aluminum or be decomposed by contact with it.

(5) Spec. 17C or 17E. Metal drums (single-trip) not over 15 gallons capacity. Authorized only for material which will not react dangerously with the drum metal, or be decomposed by contact with it.

(6) Spec. 1F. Polyethylene carboys in plywood drums. Authorized only for material which will not react dangerously with or cause decomposition of the polyethylene.

(7) Spec 6J. Steel barrels or drums having inside Spec. 2S polyethylene drum. Authorized only for material which will not react dangerously with or cause decomposition of the polyethylene.

§ 73.222 **Acetyl peroxide and acetyl benzoyl peroxide, solution.** (a) Acetyl peroxide must be shipped in solution in a non-volatile solvent and must contain not more than 25 percent by weight of the peroxide. Acetyl benzoyl peroxide must be shipped in solution in a non-volatile solvent and must contain not more than 40 percent by weight of the peroxide. They must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside containers which must be glass or earthenware, not over 1 gallon each, cushioned with incombustible packing material in sufficient quantity to absorb the contents of the inner container.

(2) Spec. 1A or 1D. Carboys, glass, boxed, capacity not over 5 gallons for spec. 1A, and 6.5 gallons for spec. 1D.

(3) Spec. 12B. Fiberboard boxes with inside containers which must be glass or earthenware, not over 1 gallon each, cushioned with incombustible packing material in sufficient quantity to absorb the contents of the inner container. Not more than one 1-gallon inside container shall be packed in one outside fiberboard box.

§ 73.223 **Peracetic acid.** (a) Peracetic acid must be shipped in solution not exceeding 40 percent strength and must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside containers which must be glass or earthenware, not over one gallon capacity each, cushioned with sterile absorbent cotton or other cushioning material which will not react with the contents to generate heat. Cushioning material must be in sufficient quantity to completely absorb the contents of the inner container.

(2) Spec 12B. Fiberboard boxes with inside containers which must be glass or earthenware, not over one quart capacity each, cushioned with sterile absorbent cotton or other cushioning material which will not react with the contents to generate heat. Cushioning material must be in sufficient quantity to completely absorb the contents of the inner container.

(3) Spec. 1D or 1F. Carboys.

(b) Peracetic acid solutions not exceeding 40 percent strength packed in strong wooden or fiberboard boxes, with not more than one inside glass container not exceeding 1 pint or 1 pound capacity, cushioned with sterile absorbent cotton or other cushioning material which will not react with the contents to generate heat, and with such cushioning material in sufficient quantity to completely absorb the contents of the bottle are exempt from specification packaging, marking other than name of contents, and labeling requirements. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

§ 73.224 **Cumene hydroperoxide, dicumyl peroxide, and tertiary butylisopropyl benzene hydroperoxide.** (a) Cumene hydroperoxide of strength not exceeding 75 percent in a non-volatile solvent, dicumyl peroxide of strength not exceeding 50 percent in a non-volatile solvent, and tertiary butylisopropyl benzene hydroperoxide not exceeding 60 percent strength must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside containers which must be glass or earthenware, not over 1 gallon each, cushioned with incombustible packing material in sufficient quantity to absorb the contents of the inner container.

(2) Spec. 17E. Metal drums (single-trip), with interiors so treated that they will be resistant to the contents.

(3) Spec. 103A or 103A-W. Tank cars. Authorized for 75 percent or less cumene hydroperoxide in nonvolatile solution.

§ 73.225 **Phosphorus sesquisulfide.** (a) Phosphorus sesquisulfide must be packed in specification containers as follows:

(1) Spec. 15A or 15B. Wooden boxes with metal inside containers hermetically sealed (soldered), or in water-tight metal cans with screw-top closures.

(2) Spec. 6A, 6B, or 6C. Metal barrels or drums, not over 30 gallons capacity each.

(3) Spec. 37A or 37B. Metal drums (single-trip). Gross weight not over 425 pounds.

§ 73.226 **Thorium metal, powdered.** (a) Thorium metal, powdered, must be packed in specification containers as follows:

(1) Spec. 15A or 15B. Wooden boxes with inside metal containers, tightly and securely closed by push-in covers held in place by soldering at least at four points, or in screw-cap type metal caps. Inside containers must not exceed 10 pounds net each. Gross weight of outside packages must not exceed 75 pounds each.

(b) Thorium metal powder packed in tightly and securely closed metal cans, cushioned with incombustible material in strong outside wooden or fiberboard boxes, and not exceeding 4 ounces net weight in one outside shipping container, is exempt from specification packaging, marking, and labeling requirements, except that marking name of contents on outside container is required for shipments via carrier by water. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C Motor Carrier Safety Regulations.

§ 73.227 **Urea peroxide.** (a) Urea peroxide must be packed in specification containers as follows:

(1) Spec. 12B. Fiberboard boxes with inside containers which must be rubber or plastic containers not exceeding 4 ounces each. Gross weight not over 65 pounds.

(2) Spec. 21A or 21B. Fiber drums completely coated on the inside with a suitable wax, synthetic coating, or metal foil suitable to the lading; or fiber drums having a metal foil (laminated between two sheets of kraft paper with thermoplastic adhesive) moisture and water barrier wound into the sidewall of the drum and located not more than 2 plies from the interior of drum but not to be wound as the first ply; a metal foil moisture and water barrier must also be present in the fiber or wood heading; exterior of drum sidewall must be protected with a water resistant coating; in addition to the tests prescribed by §§ 78.222-4 or 78.223-4, a drum having been given a 4-foot diagonal bottom chime drop must, after being emptied, withstand complete immersion of the bottom in 6 inches of water for 4 hours without leakage to the interior.

(3) Spec. 22A. Plywood drums with paper bags, spec. 2J coated with suitable wax on the inner surface.

§ 73.228 **Zinc ammonium nitrite.** (a) Zinc ammonium nitrite must be packed in specification containers as follows:

(1) Spec. 6A, 6B, or 6C. Metal barrels or drums.

(2) Spec. 17E, 17H, 37A, or 37B. Metal drums (single-trip). Gross weight not over 300 pounds.

§ 73.229 **Chlorate and borate mixtures or chlorate and magnesium chloride mixtures.** (a) Chlorate and borate mixtures or chlorate and magnesium chloride mixtures containing more than 50 percent chlorate and no other hazardous additives must be packed as follows:

(1) As prescribed in § 73.163.

(b) Chlorate and borate mixtures or chlorate and magnesium chloride mixtures containing no other hazardous additives and containing less than 50 percent chlorate are exempt from specification packaging, marking, and labeling requirements when offered for transportation by rail freight or highway and packed as follows; shipments for transportation by highway carriers are exempt also from Part 77, except section 77 817, and Part 197.

(1) Tight metal or fiber drums.

(2) Wooden boxes with tight inside metal containers.

(3) Multi-wall paper bags, net weight not over 50 pounds, moisture proof and sift proof, and having a strength capable of withstanding four 4-foot drops onto solid concrete.

(c) Chlorate and borate mixtures or chlorate and magnesium chloride mixtures containing 28 percent or less chlorate and no other hazardous additives, are not subject to the regulations in Parts 71-78 and 197.

§ 73.230 **Sodium, metallic, dispersion in organic solvent.** (a) Sodium, metallic, dispersion in organic solvent must be packed in specification containers as follows:

(1) Spec. 15A. Wooden boxes with inside containers which must be metal cans not exceeding one quart capacity, and each such can must be packed in another metal can and cushioned on all sides with at least one inch of soda ash. Both the inner and outer metal can shall be equipped with an airtight closing device secured by positive means (not friction). Gross weight of completed package must not exceed 100 pounds.

§ 73.231 **Calcium, metallic, crystalline.** (a) Calcium, metallic, crystalline must be packed in specification containers as follows:

(1) Spec. 15A or 15B. Wooden boxes with airtight inside metal containers not over 1 gallon capacity each.

(2) Spec 6A, 6B, or 6C. Metal barrels or drums, gross weight not over 350 pounds.

(3) Spec. 17C or 17H. Metal drums (single-trip), gross weight not over 350 pounds.

§ 73.232 **Tank cars containing residual phosphorus.** (a) Tank cars from which phosphorus has been unloaded and from which all residual phosphorus has not been removed by thorough cleaning must be shipped filled with water and must be placarded by the shipper with placards prescribed in § 74.555.

§ 73.233 **Nickel catalyst, finely divided, activated or spent.** (a) Nickel catalyst, finely divided, activated or spent must be wet with not less than 40 percent by weight of water or other equally suitable liquid and must be packed in specification containers as follows:

(1) Spec. 15A or 15B. Wooden boxes with airtight metal inside containers which must have closing device fastened by positive means (not friction); or airtight glass inside containers of not over 1 quart capacity each, securely cushioned in asbestos wool, vermiculite, or equally efficient incombustible cushioning material.

(2) Spec. 12B. Fiberboard boxes with airtight metal inside containers which must have closing device fastened by positive means (not friction); or airtight glass inside containers of not over 1 quart capacity each, securely cushioned in asbestos wool, vermiculite, or equally efficient incombustible cushioning material.

(3) Spec. 5, 6A, 6B, or 6C Metal barrels or drums not over 55 gallons capacity each.

(4) Spec. 17H, 37A, or 37B. Metal drums (single-trip).

§ 73.234 **Sodium nitrite.** (a) Sodium nitrite must be packed in specification containers as follows:

(1) In containers as prescribed in § 73.154.

(2) Spec. 44C. Multi-wall paper bags constructed of at least 5 thicknesses of heavy duty shipping sack Kraft paper, or equivalent, with a minimum total basis weight of 320 pounds including a polyethylene, or other suitable pliable plastic material, inner sheet having a minimum basis weight of 20 pounds. All closures must be of such design as to provide a moisture-resistant package when closed for shipment. Net weight not over 100 pounds each. Authorized for carload or truckload shipments only.

(3) Spec. 21A or 21B Fiber drums, gross weight 425 pounds; side walls must be of at least 10-ply construction having strength not less than 1,200 pounds Mullen or Cady test; drums must withstand prescribed tests when filled to authorized net weight of 400 pounds.

§ 73.235 **Ammonium bichromate.** (a) Ammonium bichromate must be packed in specification containers as follows:

(1) In containers as prescribed in § 73.154.

(2) Spec. 21A or 21B. Fiber drums, gross weight not over 425 pounds; side walls must be of at least 10-ply construction having strength not less than 1,200 pounds Mullen or Cady test; drums must withstand prescribed tests when filled to a net weight of 400 pounds.

SUBPART E—ACIDS AND OTHER CORROSIVE LIQUIDS; DEFINITION AND PREPARATION

§ 73.240 **Acids and other corrosive liquids; definition.** (a) Corrosive liquids for the purpose of Parts 71-78 are those acids, alkaline caustic liquids and other corrosive liquids which, when in contact with living tissue, will cause severe damage of such tissue by chemical action; or in case of leakage, will materially damage or destroy other freight by chemical action; or are liable to cause fire when in contact with organic matter or with certain chemicals.

§ 73.241 **Outage.** (a) Outage for containers of acids or other corrosive liquids for transportation by carriers by rail freight, rail express, highway, or water, must be as follows:

(1) The proper vacant space (outage) in a tank car or other shipping container depends on the coefficient of expansion of the liquid and the maximum increase of temperature to which it will be subjected in transit. Outage must be calculated to the total capacity of the container.

(2) Outage requirements for containers other than tank cars, cargo tanks and portable tanks. Containers must not be entirely filled. Sufficient interior space must be left vacant to prevent leakage or distortion of containers due to the expansion of the contents from increase of temperature during transit.

(3) Outage requirements for tank cars. In tank cars, outage must be calculated to percentage of the total capacity of the tank, i. e., shell and dome capacity combined. If the dome of the tank car does not provide sufficient outage, then vacant space must be left in the shell to make up the required outage. The outage for tank cars must be not less than 1 percent.

(4) Outage requirements for cargo tanks or portable tanks. No cargo tank or portable tank or compartment thereof used for the transportation of any acid or other corrosive liquid shall be completely filled. The outage for cargo tanks and portable tanks must be not less than 2 percent.

§ 73.242 **Bottles containing acid or other corrosive liquids.** (a) Bottles containing acid or other corrosive liquids, as defined by § 73.240, must not be packed in the same outside container with any other article, except as specifically provided in paragraphs (b) and (c) of this section and §§ 73.25, 73.257, 73.258, 73.259, 73.260, 73.261, or 73.286.

(b) When bottles containing acid or other corrosive liquids are cushioned by incombustible absorbent material and securely packed in tightly closed metal containers, except hydrofluoric acid which must be packed in a container other than a metal container, they may be packed with other articles. This exception does not apply to nitric acid exceeding 40 percent concentration, perchloric acid, hydrogen peroxide exceeding 52 percent strength by weight, nitrohydrochloric acid, or nitrohydrochloric acid diluted, which must not be packed in the same outside container with any other article under any circumstances.

(c) Acid or corrosive liquid solutions in securely closed bottles, in quantity necessary for preparing a single photographic processing mixture and efficiently cushioned, may be packed in the same outside container with required amount of packaged dry chemicals not classed as dangerous articles by these regulations, provided no dangerous reaction occurs should the contents of bottles and dry chemicals be mixed. Marking prescribed in § 73.401 (c) shall not be required.

§ 73.243 **Closing and cushioning.** (a) All containers must be tightly and securely closed. Inside containers must be cushioned as prescribed or in any case when necessary to prevent breakage or leakage.

§ 73.244 **Exemptions for acids and other corrosive liquids.** (a) Acids and other corrosive liquids, except those enumerated in paragraph (c) of this section, in inside bottles having a capacity not over 1 pound or 16 ounces by volume each inclosed in a metal can in the outside container are, unless otherwise provided, exempt from specification packaging, marking, and labeling requirements, except that marking name of contents on outside container is reqjuired for shipments via carrier by water. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

(b) Other exemptions from specification packaging, marking, and labeling requirements for rail freight, rail express and highway transportation and exemptions from specification packaging, marking other than name of contents, and labeling requirements for transportation by carrier by water, are shown with the packing requirements for the article.

(c) The following articles in any quantity are not exempt under the provisions of paragraphs (a) or (b) of this section:

(1) Acid sludge.

(2) Allyl chloroformate.

(3) Amyl trichlorosilane.

(4) Antimony pentafluoride.

(5) Benzyl bromide.

(6) Benzyl chloroformate.

(7) Boron trichloride.

(8) Bromine.

(9) Bromine pentafluoride.

(10) Bromine trifluoride.

(11) a-Bromotoluene.

(12) Butyl trichlorosilane.

(13) Isopropyl percarbonate, stabilized.

(14) Chloracetyl chloride.

(15) Chlorine trifluoride.

(16) Diethyl dichlorosilane.

(17) Difluorophosphoric acid, anhydrous.

(18) Dimethyl sulfate.

(19) Diphenyl dichlorosilane.

(20) Electrolyte or alkaline corrosive battery fluid packed with storage batteries, battery chargers, or radio current supply devices.

(21) Ethyl chloroformate.

(22) Ethyl phenyl dichlorosilane.

(23) Fluosulfonic acid.

(24) Hexafluorophosphoric acid.

(25) Hexyl trichlorosilane.

(26) Hydrazine, anhydrous.

(27) Hydrazine solution containing 50 percent or less of water.

(28) Hydrofluoric acid, anhydrous.

(29) Hydrogen peroxide over 52 percent strength by weight.

(30) Hypochlorite solutions containing more than 7 percent available chlorine by weight.

(31) Less-than-carload and less-than-truckload shipment of wet electric storage batteries.

(32) Methyl chloroformate.

(33) Mixtures of hydrofluoric and sulfuric acid.

(34) Monofluorophosphoric acid, anhydrous.

(35) Nitrating (mixed) acid.

(36) Nitric acid.

(37) Nitrohydrochloric acid.

(38) Nitrohydrochloric acid diluted.

(39) Octyl trichlorosilane.

(40) Phenyl trichlorosilane.

(41) Phosphorus oxychloride.

(42) Phosphorus tribromide.

(43) Phosphorus trichloride.

(44) Propyl trichlorosilane.

(45) Spent acid (sulfuric or mixed).

(46) Sulfurchloride.

(47) Thionyl chloride.

(48) Thiophosphoryl chloride.

(49) Chromyl chloride.

(50) Iodine monochloride.

§ **73.245 Acids or other corrosive liquids not specifically provided for.** (a) Acids or other corrosive liquids, as defined in § 73.240, other than those for which special requirements are prescribed, must be packed in specification containers of a design and constructed of materials that will not react dangerously with or be decomposed by the chemical packed therein, as follows:

(1) Spec. 1A, 1B, 1C, or 1E. Glass carboys in boxes, kegs or plywood drums.

(2) Spec. 1X. Boxed carboys of 5 to 6 gallons capacity; single-trip for export only. For shipment by common carriers by water to noncontiguous territories or possessions of the United States and foreign countries; shipments from inland points in the United States which are consigned to such destinations are authorized to be transported to ship side by rail freight in railroad lots only and by motor vehicle in truckload lots only.

(3) Spec. 1D. Boxed glass carboys of not over 6.5 gallons nominal capacity which must be closed, and when reused must be reconditioned and tested, as provided in the specification; means shall be provided so that accumulated pressure in bottles shall not exceed 10 pounds per square inch gauge at 130°F., or shall vent at a pressure not to exceed 10 pounds per square inch gauge

(4) Spec. 5A, 5C, or 5M. Metal barrels or drums.

(5) Spec. 10A. Wooden barrels or kegs; these containers must be asphalt lined.

(6) Spec. 11A or 11B. Wooden barrels or kegs with inside containers which must be glass or earthenware, not over 2 gallons each.

(7) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside containers which must be glass, earthenware, polyethylene or other nonfragile plastic material (bags are not authorized), not over 1 gallon each, except that inside containers up to 3 gallons are authorized when only one is packed in each outside container.

(8) Spec. 28. Metal-jacketed lead carboys.

(9) Spec 5D. Rubber lined metal barrels or drums. Any barrel or drum that shows evidence of damage must be tested before shipment for defects in lining in the manner prescribed in § 78.84-15 (a).

(10) Spec. 5H. Lead-lined metal barrels or drums.

(11) Spec. 43A. Rubber drums.

(12) Spec. 12B. Fiberboard boxes with inside containers of polyethylene, or other non-fragile plastic material resistant to the lading, and having threaded closures or other equally efficient type closure, not over 1 gallon capacity each, suitably cushioned to prevent movement within the box. Gross weight of complete package must not exceed 65 pounds.

(13) Spec. 1F or 1G. Polyethylene carboys in plywood boxes or drums, or wooden boxes.

(14) Spec 17C, 17E, or 17F. Metal drums (single-trip) with openings not exceeding 2.3 inches in diameter.

(15) Spec. 17H. Metal drums (single-trip). Authorized for viscous cleaning compounds, liquid, only.

(16) Spec. 6J. Steel barrels or drums having inside spec. 2S polyethylene drum. Gross weight restriction indicated by the gross weight embossment in the steel barrel or drum shall be waived.

(17) Spec. 17H, 37A or 37B, metal drums (single-trip), with welded side seams, not over 5 gallons capacity each. Drums must be lined throughout with a pliable plastic material impervious to the lading. Spec. 37A and 37B metal drums must be at least 24 gauge steel.

§ **73.246 Antimony pentafluoride.** (a) Antimony pentafluoride must be commercially anhydrous and must be packed in specification containers as follows:

(1) Spec. 3A150, 3AA150, 3E1800, 3B240, 4B240, or 4BA240. Cylinders closed by means of iron or steel threaded plugs.

§ **73.247 Acetyl chloride, antimony pentachloride, benzoyl chloride, benzyl chloride, chromyl chloride, pyro sulfuryl chloride, silicon chloride, sulfur chloride (mono and di), sulfuryl chloride, thionyl chloride, in tin tetrachloride (anhydrous), and titanium tetrachloride.** (a) Acetyl chloride, antimony pentachloride, benzoyl chloride, benzyl chloride, chromyl chloride, pyro sulfuryl chloride, silicon chloride, sulfur chloride (mono and di), sulfuryl chloride, thionyl chloride, tin tetrachloride (anhydrous) and titanium tetrachloride, must, except as indicated, be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with glass or earthenware inside containers not over 1 gallon each, except that inside containers up to 3 gallons each are authorized when only one is packed in an outside container.

(2) Spec. 11A or 11B. Wooden barrels or kegs, with glass or earthenware inside containers not over 2 gallons each.

(3) Spec. 1A, 1C, 1D, or 1E. Glass carboys in boxes, kegs, or plywood drums (not permitted for antimony pentachloride or tin tetrachloride, anhydrous).

(4) Spec. IX. Boxer carboys of 5 to 6 gallons capacity; single-trip for export only. For shipment by common carriers by water to noncontiguous territories or possessions of the United States and foreign countries; shipments from inland points in the United States which are consigned to such destinations are authorized to be transported to ship side by rail freight in carload lots only and by motor vehicle in truckload lots only (not permitted for antimony pentachloride or tin tetrachloride anhydrous).

(5) Spec. 5A or 17C (single-trip). Metal barrels or drums with openings not exceeding 2.3 inches in diameter. Benzyl chloride must be stabilized when packed in unlined containers.

(6) Spec. 103A, 103A-W, 105A300-W, 105A400-W, 105A500-W, or 105A600-W tank cars, except that for tin tetrachloride (anhydrous) spec. 105A300-W, 105A400-W, 105A500-W, or 105A600-W tank cars must be used. Benzyl chloride must be stabilized when loaded in unlined tanks

(7) Spec. 5H. Metal barrels or drums, lead-lined, authorized for benzyl chloride only.

(8) Sulfur chloride packed in glass or earthenware bottles or carboys must be cushioned in the outside container by means of incombustible elastic packing material of such nature that a mixture of the liquid and the packing material will not cause fires or heating.

(9) Spec. MC 310 and MC 311 Tank motor vehicles Benzyl chloride must be stabilized when loaded in unlined tanks.

(10) Spec. 5K. Nickel drums, authorized for acetyl chloride, benzyl chloride, benzoyl chloride, pyro sulfuryl chloride, sulfuryl chloride, and thionyl chloride only. When shipped in unstabilized condition, the lading must

be anhydrous and must be free from impurities such as iron.

(11) Spec. 103A-N-W. Tank cars, authorized for benzyl chloride only. When shipped in unstabilized condition, the lading must be anhydrous and must be free from impurities such as iron All cast metal parts of the tank in contact with the lading must have a minimum nickel content of approximately 96.7 percent.

(12) Spec. 60. Portable tanks. Benzyl chloride must be stabilized when loaded in unlined tanks.

(13) Spec. 103A or 103-W tank cars. Tank cars, nickel clad at least 10 percent, authorized for stabilized benzyl chloride only. Acetyl chloride, benzoyl chloride, pyro sulfuryl chloride, sulfuryl chloride, and thionyl chloride when shipped in unstabilized condition, must be anhydrous and free from impurities such as iron.

(14) Spec. 5C. Barrels or drums of type 304 stainless steel not over 30 gallons capacity each. Authorized for chromyl chloride only.

(15) Spec. 42D Aluminum drums not over 30 gallons capacity each. Authorized for chromyl chloride only.

(16) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with aluminum bottles of 99 percent pure aluminum not over 1 gallon capacity each, having aluminum screw caps with gasket resistant to the contents. Authorized for chromyl chloride only.

(17) Spec. 103-W. Tank cars authorized for titanium tetrachloride, anhydrous only. Tank cars shall have no bottom outlets and shall have safety valves of approved type with start-to-discharge pressure of 35 pounds per square inch and of sufficient relieving capacity to prevent pressure build-up in excess of 45 pounds per square inch.

(18) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes having inside containers of securely closed soft-lead tubes having not more than 65 fluid ounces capacity each, which tubes shall be individually packed in securely closed steel tubes, with not more than 3 such steel tubes fastened together as a unit. The inside units shall be surrounded on all sides with incombustible mineral material. Authorized for titanium tetrachloride only.

§ 73.248 **Acid sludge, sludge acid, spent sulfuric acid, or spent mixed acid.** (a) Acid sludge, sludge acid, spent sulfuric acid, or spent mixed acid, resulting from the use of sulfuric acid in various processes, except when containing hydrofluoric acid, which will not corrode interior of tank cars at sufficiently rapid rate to cause leakage during transportation, must be packed in specification containers as follows:

(1) Spec. 1A, 1D, or 1E. Carboys in boxes of plywood drums. (For spent sulfuric acid only.)

(2) Spec. 1X. Boxed carboys of 5 to 6 gallons capacity; single-trip for export only. For shipment by common carriers by water to noncontiguous territories or possessions of the United States and foreign countries; shipments from inland points in the United States which are consigned to such destinations are authorized to be transported to ship side by rail freight in carload lots only and by motor vehicle in truck load lots only.

(3) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside containers which must be glass or earthenware, not over 1 gallon each, except that inside containers up to 3 gallons are authorized when only one is packed in each outside container.

(4) Spec. 103A or 103A-W Tank cars, provided the product is sufficiently liquid to be unloaded through the dome.

(5) Spec. 103 or 103W. Tank cars, provided the product is too viscous to be unloaded through the dome.

(6) Spec. MC 310 and MC 311. Tank motor vehicles.

(7) Spec. 60. Portable tanks.

§ 73.249 **Alkaline corrosive liquids, n.o.s., alkaline caustic liquids, n.o.s., alkaline battery liquids, and sodium aluminate, liquid.** (a) Alkaline corrisive liquids, n.o.s., alkaline caustic liquids, n.o.s., alkaline battery fluids, and sodium aluminate, liquid, when offered for transportation by carriers by rail freight, highway, or water must be packed in specification containers of a design and constructed of materials that will not react dangerously with or be decomposed by the chemical packed therein as follows:

(1) In containers prescribed in § 73.245 of this part.

(2) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with glass or earthenware inside containers, not over 2 gallons each, or with metal inside containers, not over 5 gallons each.

(3) Spec. 5 or 5A. Metal barrels or drums, with openings not exceeding 2 3 inches in diameter.

(4) Spec. 17H. Metal drums (single-trip). Authorized only or liquid boiler compounds or liquid water treatment compounds.

(5) Spec. 103, 103-W, 103A, 103A-W, 104, 104-W, 105A100, or 105A100-W Tank cars.

(6) Spec MC 310 or MC 311, tank motor vehicles.

(7) Spec. 60, portable tanks.

(8) Spec. 12B. Fiberboard boxes with glass inside containers of not over 16 ounces capacity each.

(9) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside containers of polyethylene having capacity not over 1 gallon each.

(10) Spec. 12B. Fiberboard boxes, with not more than one glass inside container not over 1 gallon capacity containing sodium hydroxide solution not over 25 percent strength and packed in a strong fiberboard box. Dry chemicals for photographic development process not classed as dangerous articles, contained in suitable inside packages, may be packed in the same outside box. The marking requirements of § 73.401 (c) shall not apply.

(b) Alkaline corrosive liquids, n.o.s., alkaline caustic liquids, n.o.s., alkaline battery fluids, and sodium aluminate, liquid, when offered for transportation by rail express, must be packed in specification containers as follows:

(1) In containers as prescribed in § 73.249 (a) (8), (9) and (10).

(2) Spec. 5 or 5A. Metal barrels or drums, capacity not exceeding 10 gallons, with openings not exceeding 2.3 inches in diameter.

(3) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with glass or earthenware inside containers not over 1 gallon each, or with metal cans not over 5 gallons each.

(c) Inside containers of not more than 8-fluid ounces capacity each, resistant to lading, packed in strong outside containers, and cushioned with absorbent material in sufficient quantity to completely absorb liquid contents in the event of breakage, are exempt from specification packaging, marking, and labeling requirements, except that marking name of contents on outside container is required for shipments via carrier by water. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C Motor Carrier Safety Regulations.

§ 73.250 **Automobiles or other self-propelled vehicles, engines or other mechanical apparatus.** (a) Automobiles and other self-propelled vehicles equipped with electric storage batteries, wet, or with electric storage batteries, wet, removed from vehicles; and electric storage batteries, wet when included in carload or truckload shipments of automobile parts or assembled material in accordance with subparagraphs (a) (1), (2), and (3) are exempt from specification packaging, marking, and labeling requirements. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations. (See also § 73.257 (b)).

(1) When batteries are removed from automobiles and loaded into car or motor vehicle therewith, the batteries must be so loaded, blocked, and braced in car as to prevent movement therein during transit, and the load

must be so arranged that loose articles cannot come into contact with the batteries.

(2) When batteries are shipped with automoble parts or assembly material, the batteries must be boxed or crated and so loaded, blocked, and braced in the car or motor vehicle as to prevent movement therein during transit, and the load must be so arranged that loose articles cannot come into contact with the batteries.

(3) When batteries are installed in the vehicle, they must be completely protected so that short circuits will be prevented and so secured that leakage of acid will not occur under conditions normal to transportation

(b) Engines or mechanical apparatus of such size or weight as to require securement to skids to facilitate handling may have electric storage batteries, wet, necessary for the operation thereof, either securely fastened in the holder provided on the equipment and protected, including battery terminals, in such manner as to prevent damage thereto or short circuits, or completely boxed in containers of sound lumber and with filling holes upright, securely fastened to the skids upon which the engine or mechanical apparatus is mounted to prevent accidental tipping or looseness in transportation Electric storage batteries, wet, as described herein are exempt from specification packaging.

§ 73.251 **Boron trichloride.** (a) Boron trichloride must be packed in specification containers as follows:

(1) Cylinders as prescribed for any compressed gas, except acetylene.

(2) Spec. 105A300W, 106A500, or 106A500X. Tank cars.

§ 73.252 **Bromine.** (a) Bromine must be packed in specification containers as follows:

(1) Spec. 15A or 15B. Wooden boxes with glass inside containers not over 1 quart each; or with stone or earthenware jugs not over 1 gallon each.

(2) Spec. 5H. Lead-lined metal barrels or drums not over 10 gallons each.

(3) Spec. 105A300-W Tank cars. The tank must be nickel clad at least 20 percent or must be lined with lead at least 3/16 inch thick; openings in tank heads to facilitate application of lead lining are authorized and must be closed in an approved manner; all closures and appurtenances which are in contact with the lading must be lead lined or must be made of metal not subject to rapid deterioration by contact with the lading; all interior welds in nickel clad tanks must be protected by pure nickel butt straps to eliminate iron contamination. Except as otherwise provided herein the water weight capacity of the tank must not be more than 20,400 pounds, and the maximum quantity of liquid bromine loaded into the tank must not be more than 60,000 pounds or 300 percent of the water weight capacity of the tank, whichever quantity is the lesser. In no case shall the quantity loaded be less than 98 percent of the quantity the tank is authorized to carry. When tanks are equipped with manway cover plates, safety valves, venting, loading and unloading valves in accordance with spec. ICC-105A300-W, and tank jackets are stencilled ICC-105A300-W, but in all other respects are constructed and maintained in full compliance with spec. ICC-105A500-W, the water weight capacity of the tank must not be more than 37,400 pounds, and the maximum quantity of liquid bromine loaded into the tank must not be more than 110,000 pounds or 300 percent of the water weight capacity of the tank, whichever quantity is the lesser.

(b) Outage (vacant space above liquid) for inside containers must be not less than 15 percent of capacity of container.

(c) For other authorized containers an outage of not less than 10 percent is required.

(d) Inside containers must be closed by glass, earthenware, or stone stoppers ground to fit and securely fastened; or bottles may have necks with molded screw threads which must be closed by threaded-type caps with lead or other efficient bromine-resistant gaskets and cushioned by elastic material to insure tight closure. Sealed glass ampoules are also authorized.

(e) Bottles or jugs must be securely cushioned on all sides with incombustible packing material, such as whiting, mineral wool, infusorial earth (kieselguhr), sifted ashes, powdered china clay, or similar material, at least 1 inch thick, which will not produce heat when mixed with bromine. The use of hay, sawdust, excelsior, or other organic material, either treated or untreated, as a cushioning or packing material, is prohibited.

(f) Not more than 15 quarts of bromine in bottles, nor more than 12 quarts in jugs, may be packed in one box.

(g) Bromine which has been dried in accordance with good commercial practice may also be packed in specification containers as follows:

(1) Spec. 5K or 5M. Nickel or monel drums of not over 10 gallons capacity each and containing not more than 225 pounds net weight of bromine. Drums must be of metal at least 14 gauge United States standard throughout and must have chime reinforcement adequate for their protection. All openings must be in one head and closing parts (plug, cap, flange, etc.) must be of the same metal as the drum. One opening not over 2.3 inch diameter and one opening not over ¾ inch standard pipe size are permitted. Each drum must be completely emptied and dried before reuse and must be equipped with gaskets of a material approved by the Bureau of Explosives.

§ 73.253 **Chloracetyl chloride.** (a) Chloracetyl chloride must be packed in specification containers as follows:

(1) Spec. 15A or 15B. Wooden boxes, with inside glass containers not over 5 pints capacity each, cushioned with incombustible material.

(2) Spec. 28. Metal-jacketed lead carboys.

(3) Spec. 5H. Lead-lined metal barrels or drums

(4) Spec. 1A, 1C, or 1D. Carboys in boxes or kegs. Use of these containers will be permitted because of the present emergency and until further order of the Commission.

(5) Spec. 5K. Nickel drums.

§ 73.254 **Chlorosulfonic acid and mixtures of chlorosulfonic acid-sulfur trioxide.** (a) Chlorosulfonic acid and mixtures of chlorosulfonic acid trioxide must be packed in specification containers as follows:

(1) Spec. 5A or 5C. Metal barrels or drums.

(2) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes, with inside containers which must be glass or earthenware, not over 1 gallon each, except that inside containers up to 3 gallons are authorized when only one is packed in each outside container

(3) Spec. 11A or 11B. Wooden barrels, with inside glass or earthenware containers not over 2 gallons each.

(4) Spec. 103A, 103A-W, 103C-W, or 103E-W. Tank cars.

(5) Spec. MC 310 and MC 311. Tank motor vehicles.

§ **73.255.** Dimethyl sulfate. (a) Dimethyl sulfate must be packed in specification containers as follows:

(1) Spec. 5A or 5C. Metal barrels or drums not over 55 gallons each. Spec. 5C metal barrels or drums must be constructed of Type 304 stainless steel

(2) Spec. 5. Metal barrels or drums not over 15 gallons each, with openings not exceeding 2.3 inches in diameter, inclosed in strong crates made of lumber at least ⅝ inch thick.

(3) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with each box containing a single glass inside container not over 1 quart capacity, closed by ground glass stopper or other equally efficient closure securely fastened in place, and cushioned with incombustible absorbent material in hermetically sealed (soldered) metal can, the can then being cushioned with incombustible cushioning material in the outside container.

(4) Spec. 103A or 103A-W. Tank cars.

§ 73.256 **Compounds, cleaning, liquid.** (a) Compounds, cleaning, liquid, containing not more than 60 percent hydrofluoric acid, must be packed in specification containers as follows:

(1) As prescribed in § 73.264 (a) (1) and (2) of this part.

(2) Spec. 12B Fiberboard boxes with inside containers of natural rubber, ceresine, lead, or other material of equal strength and not subject to destruction by the lading.

(3) Spec. 22B. Plywood drums equipped with molded liner of type and material approved by the Bureau of Explosives.

§ 73.257 **Electrolyte (acid) or corrosive battery fluid.** (a) Electrolyte (acid) must not be over 47 percent strength (39° Baume). Electrolyte or corrosive battery fluid must be packed in specification containers as follows:

(1) As prescribed in § 73.272 of this part except that unlined tank cars and metal barrels or drums must not be used.

(2) Spec. 43A. Rubber drums.

(3) When the material is alkaline it may also be shipped when packed in containers as prescribed in § 73.249 of this part.

(4) Spec. MC 310 and MC 311. Tank motor vehicles, except that unlined tanks must not be used.

(5) Spec. 60. Portable tanks, except that unlined tanks must not be used.

(6) Spec. 12B or 12C. Fiberboard boxes with inside containers of polyethylene or other electrolyte acid resistant non-fragile materials having secure closures capable of withstanding conditions incident to transportation without leakage and unless containers are rigid or semirigid in nature they must be contained in other strong inside containers; minimum thickness of polyethylene or other materials shall be not less than 0.003 inch for any film sheet for multi-wall containers or not less than 0.006 inch for single wall containers; not more than 12 such inside containers shall be packed in one outside box and the marking prescribed in § 73.401 (c) shall not be required. Inside containers shall be packed to prevent movement within the box. Dry storage batteries or battery charger device may be packed in the same outside box when adequately separated from other inside containers; gross weight of completed package shall not exceed 65 pounds. Complete package, closed as for shipment, with inside containers filled with liquid of same specific gravity as commodity to be shipped, must be capable of withstanding at least 2 drops from a height of 4 feet onto solid concrete without leakage from or rupture of inside containers.

(7) Spec. 15A, 15B, 15C, 16A, or 19A Wooden boxes with inside containers of polyethylene, or other electrolyte acid resistant plastic, not over 1 gallon each.

(8) Spec. 1EX. Carboys in plywood drums (single-trip).

(9) Spec. 12B. Fiberboard boxes constructed of at least 275-pounds test (Mullen or Cady) double-wall corrugated fiberboard or 325-pound test (Mullen or Cady) double-faced corrugated fiberboard, with not more than 12 inside glass bottles, having acid-proof closures, of not over 32 ounces capacity each. Inside glass bottles must be separated and cushioned by suitable corrugated fiberboard partitions. The box must be equipped with top and bottom pads. (See § 78.205-32.)

(10) Spec. 12B. Fiberboard boxes having not more than 1 inside glass bottle, with acid-proof closure, not over 1 gallon capacity Box shall be constructed of at least 350-pound test (Mullen or Cady) double-faced corrugated fiberboard of full depth telescope type. Cushioning and closure of box (pressure sensitive tape may be used) must be such that a representative box, with inside glass bottle filled with water, shall be capable of withstanding two drops from a height of 4 feet onto solid concrete without breakage of inner bottle or failure of the closure.

(b) Shipments of electrolyte (acid) or corrosive battery fluid with vehicles offered for transportation by, for, or to the Departments of the Army, Navy, or Air Force of the United States Government are exempt from Parts 71-78 and 197 when packed as follows:

(1) In one inside glass bottle of not over 1 gallon capacity, tightly and securely closed, packed in a strong outside container and cushioned therein on all sides with incombustible absorbent material in sufficient quantity to completely absorb liquid contents in event of breakage. Outside container must be so blocked, braced or stayed within the vehicle that it cannot change position during transit.

§ 73.258 **Electrolyte, acid, or alkaline corrosive battery fluid, packed with storage batteries.** (a) Electrolyte, acid, or alkaline corrosive battery fluid, packed with storage batteries, except as provided in § 73.257 (a) (6), must be packed in specification containers as follows:

(1) Spec. 15D or 16B. Wooden boxes with inside containers of glass bottles not over 1 gallon each nor over 2 gallons total in each outside container. Inside containers must be well cushioned and separated from batteries by a strong solid wooden partition.

§ 73.259 **Electrolyte, acid, or alkaline corrosive battery fluid, packed with battery charger, radio current supply device, or electronic equipment.** (a) Electrolyte, acid, or alkaline corrosive battery fluid packed with battery charger, radio current supply device or parts thereof, or electronic equipment, with only one device or outfit in each such package, in the amount necessary for operation of the device or equipment, provided the containers of electrolyte, acid, or alkaline corrosive battery fluid, are adequately cushioned to prevent breakage, leakage, or damage to other articles packed therewith, must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes, provided the liquid is in bottles securely closed and cushioned as prescribed in paragraph (a) of this section, and separated from charger supply device, and parts, or electronic equipment by a strong solid wooden partition.

(2) Spec. 12B. Fiberboard boxes, when the liquid is in a strong bottle not exceeding 16 fluid ounces, which must be securely closed and cushioned as prescribed in paragraph (a) of this section. Not more than 12 such packages may be packed under the provisions of § 73.25.

§ 73.260 **Electric storage batteries, wet.** (a) Electric storage batteries, containing electrolyte acid or alkaline corrosive battery fluid, must be completely protected so that short circuits will be prevented; they must not be packed with other articles except as provided in §§ 73.250 and 73.258, portable searchlights properly cushioned, battery parts, or hydrometers, securely packed in a separate container. The batteries either with or without other articles must be packed in specification containers as follows:

(1) Spec 15D or 16B. Wooden or wirebound wooden boxes except as provided in paragraphs (b) and (c) of this section.

(2) Spec. 12B. Fiberboard box as authorized by §§ 78.205-25 (a) and 78.205-28 (a).

(3) Electric storage batteries with case of asphaltum composition, impregnated rubber, steel case type, synthetic resin (plastic), or wooden battery box type, protected against short circuits and firmly secured to skids or pallets capable of withstanding the shocks normally incident to transportation, are exempt from specification packaging requirements for transportation by rail freight, highway, or water. The height of the completed unit must not exceed 1½ times the width of the skid or pallet. The unit must weigh not less than 300 pounds gross and must not fail under a superimposed weight equal to two times the weight of the unit or a superimposed weight of 4,000 pounds if the weight of the unit exceeds 2,000 pounds. Battery terminals must not be relied upon to support any part of the superimposed weight.

(4) Electric storage batteries weighting 500 pounds or more, with case of asphaltum composition, impregnated rubber, steel case type, synthetic resin (plastic) or wooden battery box type, consisting of carriers' equipment may be shipped by rail freight when mounted on suitable skids and protected against short circuits. Such shipments must not be offered in interchange.

(b) Electric storage batteries with case of asphaltum composition, impregnated rubber, steel case type, synthetic resin (plastic), or wooden battery box type; packing authorized as follows:

(1) One to three batteries not over 25 pounds each in outside box, gross weight not over 75 pounds; specification container not required.

(2) Not more than four batteries not over 15 pounds each may be packed in strong outside fiberboard or wooden boxes, when securely cushioned and packed to prevent short circuits; specification container not required. Authorized gross weight 65 pounds.

(c) Single batteries not exceeding 75 pounds each, in addition to requirements of paragraphs (a) and (b) of this section, may be shipped in 5-sided slip covers or in completely closed fiberboard boxes, or solid or double-faced corrugated fiberboard complying with the following: (See paragraph (a) (1) of this section for more than one battery in an outside container.)

(1) Slip cover or fiberboard box must fit snugly and provide inside top clearance of at least ½ inch above battery terminals and filler caps with reinforcement in place. Assembled for shipment, the bottom edges of the slip cover must not extend to the base of the battery but must not expose more than 1 inch thereof.

(2) Top of slip cover or fiberboard box must have interior reinforcement (insert or saddle) of fiberboard, wood, or other material of equal strength and rigidity so formed that any superimposed weight will bear only and directly downward on the top edges of the battery case or intercell connectors (straps). When top of slip cover or fiberboard box consists of only one thickness of material, reinforcement must have a plane surface of same interior dimensions and thickness. Reinforcement must be of a height to provide minimum clearance required above and must be constructed to remain securely in place or be fastened to slip cover or fiberboard box.

(3) All fiberboard must be at least 200 pound test (Mullen) and completed package (battery and slip cover or fiberboard box) must be capable of withstanding top-to-bottom compression tests of at least 500 pounds without damage to battery terminals or filler caps.

(d) Electric storage batteries, containing electrolyte or corrosive battery fluid, of the nonspillable type, protected against short circuits and completely and securely boxed are exempt from specification packaging, marking, and labeling requirements, except that marking name of contents on outside container is required for shipments via carrier by water. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

(e) Shipments of electric storage batteries containing electrolyte or battery fluid, loaded or braced to prevent damage in transit and short circuits, are exempt from Parts 71-78 and 197: Provided, however, that storage batteries (either wet or dry) constitute the only commodity being transported in the railroad car or motor vehicle body.

(f) Electric storage batteries containing electrolyte or corrosive battery fluid, other than those of the nonspillable type, when shipped in less-than-carload and less-than-truckload lots, must be marked and labeled as required by §§ 73.401 (a), (c), and 73.402 (a) (3) of this part.

§ **73.261 Fire-extinguisher charges.** (a) Fire-extinguisher charges consisting of sulfuric acid in glass inside containers securely closed may be packed with bicarbonate of soda in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with glass inside containers not over 5 pints each, cushioned.

(2) Spec. 21A or 21B. Fiber drums with a single inside container consisting of a glass bottle not over 64 fluid ounces capacity filled with not over six pounds by weight of sulfuric acid (approximately 50 fluid ounces by volume). Bottle must be suspended in center of outside container by means of adequate supports and surrounded by bicarbonate of soda in sufficient quantity to fill drum and neutralize contents in the event of breakage.

(b) Fire-extinguisher charges as described in subparagraphs (1) to (3) of this paragraph are exempt from specification packaging, marking, and labeling requirements, except that marking name of contents on outside container is required for shipments via carrier by water. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

(1) Fire-extinguisher charges consisting of sulfuric acid in strong 8-fluid ounces or smaller bottles, securely closed and packed with bicarbonate of soda completely surrounding the bottles of acid in outside fiberboard or wooden boxes. Closure must consist of a metal cap lined with an acid-resistant washer or a composition stopper of material that will not be attacked by the acid.

(2) Fire-extinguisher charges, consisting of chlorosulfonic acid in a hermetically sealed bottle not exceeding 2 ounces capacity, securely packed in a metal container inclosed in another metal container, the inner metal container being cushioned in the outer metal container with asbestos fabric and the completed package embedded in potassium carbonate in outside fiberboard or wooden boxes.

(3) Fire-extinguisher charges, consisting of sulfuric acid in 10-ounce or smaller bottles, securely closed, packed in a tight fiber carton Closure must consist of a metal cap lined with an acid-resistant washer or a composition stopper of material that will not be attacked by the acid. The bottle and carton packed in either potassium carbonate or potassium carbonate and alkali packed in a cylindrical tin can, with slip cover, secured by tape in outside fiberboard or wooden boxes.

§ **73.262 Hydrobromic acid.** (a) Hydrobromic acid not over 49 percent strength must be packed in specification containers as follows:

(1) Spec. 1A, 1C, 1D, 1E, or 1F. Carboys in boxes, kegs, or plywood drums.

(2) Spec. 1X. Boxed carboys of 5 to 6 gallon capacity; single-trip for export only. For shipment by common carriers by water to noncontiguous territories or possessions of the United States and foreign countries; shipments from inland points in the United States which are consigned to such destinations are authorized to be transported to ship side by rail freight in carload lots only and by motor vehicle in truckload lots only.

(3) Spec. 11A or 11B. Wooden barrels or kegs with glass or earthenware inside containers, not over 2 gallons each.

(4) Spec. 15A, 15B, 15C, 16A, or 19A Wooden boxes with inside containers which must be glass or earthenware, not over 1 gallon each, except that inside containers up to 3 gallons are authorized when only one is packed in each outside container.

(5) Spec. 43A. Rubber drums. Any such container showing evidence of damage must be tested to 20 pounds hydrostatic pressure, without leakage, before using.

(6) Spec. 103B or 103B-W. Tank cars.

(b) Hydrobromic acid greater than 49 percent strength but not over 63 percent strength must be packed in specification containers as follows:

(1) Spec. 1F. Polyethylene carboys in plywood drums.

§ **73.263 Hydrochloric (muriatic) acid, hydrochloric (muriatic) acid mixtures, hydrochloric (muriatic) acid solution, inhibited, sodium chlorite solution, and cleaning compounds, liquid, containing hydrochloric (muriatic) acid.** (a) Hydrochloric (muriatic) acid, hydrochloric (muriatic) acid mixtures, hydrochloric (muriatic) acid solution, inhibited, sodium chlorite solution not exceeding 40 percent sodium chlorite, and cleaning compounds, liquid, containing hydrochloric (muriatic) acid must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside containers which must be glass, earthenware, polyethylene or other nonfragile plastic material resistant to the lading (bags are not authorized), not over 1 gallon each, except that inside containers up to 3 gallons each

are authorized when only one is packed in each outside container

(2) Spec. 5D Rubber-lined metal barrels or drums. Any such container that shows evidence of damage must be tested, before shipment, for defect in lining in the manner prescribed in spec. 5D.

(3) Spec. 43A. Rubber drums.

(4) Spec. 11A or 11B. Wooden barrels or kegs with glass or earthenware inside containers not over 2 gallons each.

(5) Spec. 1A or 1C. Carboys in boxes or kegs.

(6) Spec. 1X. Boxed carboys of 5 to 6 gallons capacity; single-trip for export only. For shipment by common carriers by water to noncontiguous territories or possessions of the United States and foreign countries; shipments from inland points in the United States which are consigned to such destinations are authorized to be transported to ship side by rail freight in carload lots only and by motor vehicle in truckload lots only.

(7) Spec. 1D, 1E, or 1EX (single-trip). Glass carboys in boxes or plywood drums, of not over 6.5 gallons nominal capacity. Means shall be provided so that accumulated total pressure in bottle shall not exceed 10 p.s.i. gauge at 130°F. or shall vent at a pressure not to exceed 10 p.s.i. gauge.

(8) Spec. 10A. Rubber-lined wooden barrels or kegs.

(9) Spec. 103B or 103B-W Tank cars. Authorized for acid not over 38 percent strength by weight. Except for hydrochloric (muriatic acid) of 22° Baume strength, and other fuming acids, safety vent of approved design equipped with frangible disc having ⅛ inch breather hole in the center thereof or a safety vent of approved design equipped with carbon discs permitting continuous venting may be used.

NOTE 1: Because of the present emergency and until further order of the Commission, hydrochloric acid may be offered for transportation by carriers by water in conformity with Regulations for Explosives or Other Dangerous Articles on Board Vessels, 46 CFR 146.23-13 issued by the Commandant of the Coast Guard.

(10) Spec. MC 310 and MC 311. Tank motor vehicles, lined with rubber or equally acid-resistant material of equivalent strength and durability.

(11) Spec. 60. Portable tanks, rubber-lined.

(12) Spec. 103B100-W. Tank cars. Authorized for acid not over 44½ percent strength by weight.

(13) Spec. 1F, IG, or 1H Polyethylene carboys in wooden boxes, plywood drums or boxes, or metal crates.

(14) Spec. 17H, 37A, or 37B. Metal drums (single-trip) not over 5 gallons capacity each. Authorized only for hydrochloric (muriatic) acid solution, inhibited, containing not to exceed 15 percent hydrochloric (muriatic) acid. Drums must be lined throughout with a pliable plastic material impervious to the solution. Spec. 37A and 37B metal drums must be at least 24 gauge steel.

(15) Spec. 12B. Fiberboard boxes with inside containers of polyethylene, or other nonfragile plastic material resistant to the lading (bags are not authorized), not over 1 quart capacity each, suitably cushioned to prevent movement within the box. Gross weight of complete package must not exceed 65 pounds.

(17) Spec. 6J. Steel barrels or drums having inside spec. 2S polyethylene drum Gross weight restriction indicated by the gross weight embossment in the steel barrel or drum shall be waived.

(b) Hydrochloric acid of not over 20 percent strength (13.25° Baume) and other corrosive liquids containing not over 20 percent hydrochloric acid in addition to containers prescribed in paragraph (a) of this section may be shipped in specification containers as follows:

(1) Spec. 10A. Asphaltum-lined wooden barrels or kegs.

(2) Inside containers of not more than 8-fluid ounces capacity each, resistant to lading, packed in strong outside containers, and cushioned with absorbent material in sufficient quantity to completely absorb liquid contents in the event of breakage, are exempt from specification packaging, marking, and labeling requirements, except that marking name of contents on outside container is required for shipments via carrier by water. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

(c) When hydrochloric acid contains oils or solvents it must not be shipped in containers or tank cars lined with rubber.

(d) Hydrochloric acid mixtures of not over 28 percent strength, or cleaning compounds, liquid, containing not over 28 percent hydrochloric (muriatic) acid, in addition to the provisions of paragraphs (a) and (b) of this section, may be packed in specification containers as follows:

(1) Spec. 12B. Fiberboard boxes constructed of at least 275-pound test (Mullen or Cady) double-wall corrugated fiberboard or 325-pound test (Mullen or Cady) double-faced corrugated fiberboard, with not more than 12 inside glass bottles, having acid-proof closures, of not over 32 ounces capacity each. Inside glass bottles must be separated and cushioned by suitable corrugated fiberboard partitions The box must be equipped with top and bottom pads. (See § 78.205-32.)

§ 73.264 **Hydrofluoric acid.** (a) Hydrofluoric acid must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside containers of natural rubber, ceresine, lead, or other hydrofluoric acid resistant material. These containers are authorized only for strengths of acid for which they are adequate, but in no case may the strength of acid exceed 70 percent.

(2) Spec. 12B. Fiberboard boxes with inside containers of natural rubber, lead, polyethylene, or other hydrofluoric acid resistant plastic not over one pound capacity each. These containers are authorized only for strengths of acid for which they are adequate, but in no case shall the strength of acid exceed 70 percent.

(7) Spec. 5A. Unlined metal barrels or drums which have been subjected to adequate passification or neutralization process (see Note 1). Authorized only for acid of not less than 60 percent and not more than 80 percent strength, and all containers must be filled to not over 80 percent of capacity at 68° F. If containers are washed out with water, they must be repassified before reshipment. (See Notes 1, 2, 3, 4 and 5.)

NOTE 1: Each metal container, before being put into service, must be passified by an efficient method.

NOTE 2: Containers not exceeding 55 gallons capacity each are authorized for carload, truckload, less-than-carload, and less-than-truckload shipment. Containers exceeding 55 gallons capacity each are authorized for carload or truckload shipments only but they must be loaded by consignor and unloaded by consignee.

NOTE 3: For less-than-carload or less-than-truckload shipments, containers must be of metal at least as heavy as 14 gauge United States standard for not over 20 gallons capacity each or 12-gauge for not over 55 gallons capacity each. Each container must be subjected to at least one of the following tests before shipment: By interior pressure of at least 15 pounds per square inch before filling or by holding for inspection for at least 24 hours after filling. In either case, each container must be vented prior to shipment.

NOTE 4: Because of the present emergency and until further order of the Commission, containers of not over 55-gallons capacity each, of 14-gauge metal, are authorized, provided test requirements of Note 3 are maintained and provided containers are retired from service after showing a 15 percent loss of tare weight.

NOTE 5: Hydrofluoric acid solutions and concentrations of 60 percent up to 65 percent, when shipped in unlined steel containers, must be inhibited so that the corrosive effect on steel must not be greater than that of hydrofluoric acid of 65 percent concentration.

(8) Spec. 103A, 103A-W, 105A100, 105A100-W, 105A300-W, 105A400-W, 105A500-W, 105A600-W, or

ARA-IV-A[1]. Unlined metal tanks which have been subjected to adequate passivity or neutralization process. (See Note 1 to subparagraph (7) of this paragraph.) Authorized only for acid of 60 to 80 percent strength If tanks are washed out with water they must be resubjected to passivity before reshipment.

NOTE 1: Hydrofluoric acid solutions and concentrations of 60 percent up to 65 percent, when shipped in unlined metal tank cars, must be inhibited so that the corrosive effect on steel must not be greater than that of hydrofluoric acid of 65 percent concentration.

(9) Spec. 43A. Rubber drums. Authorized only for acid not over 65 percent strength. Any such container showing evidence of damage must be tested to 20 pounds hydrostatic pressure, without leakage, before using.

(10) Spec. 5D. Lined metal barrels or drums. Authorized only for acid not over 62 percent strength. Any barrel or drum that shows evidence of damage must be tested before shipment for defects in lining in the manner prescribed in § 78.84-15 (a). Lining materials must meet the test prescribed in Notes 1, 2, and 3 below.

NOTE 1: Performance test. Test panels of linings for drums in hydrofluoric acid service must be subjected to a test in 62 percent hydrofluoric acid for a period of not less than 90 days. At the end of such period there must be no signs of deterioration of such lining material from chemical attack as evidenced by changes in its physical characteristics, and no signs of permeation of hydrofluoric acid through the sample as evidenced by blistering from the metal insert

NOTE 2: Method of test. The test panel should be at least 2 inches by 6 inches with a steel insert completely covered by lining material. Test panels should be immersed in 62 percent hydrofluoric acid so that 50 percent of the panel is in contact with liquid and 50 percent in contact with vapor. Temperature of test to be maintained at 130°F. for the entire 90 days.

NOTE 3: Drums may be lined with material at least as thick as the sample material tested.

(11) Spec. 103B or 103B-W. Tank cars, rubber-lined tanks. Authorized only for acid not over 40 percent strength.

(14) Spec. MC 310 and MC 311. Tank motor vehicles.

NOTE 1: Hydrofluoric acid solutions and concentrations of 60 percent up to 65 percent, when shipped in unlined tank motor vehicles, must be inhibited so that the corrosive effect on steel must not be greater than that of hydrofluoric acid of 65 percent concentration.

(16) Spec. 1F or 1G Polyethylene carboys in plywood boxes or drums, or wooden boxes. Authorized for acid not over 60 percent strength.

(17) Spec. 6J. Steel barrels or drums having inside spec. 2S polyethylene drum. Authorized for acid not over 60 percent strength. Gross weight restriction indicated by the gross weight embossment in the steel barrel or drum shall be waived.

(b) Hydrofluoric acid, anhydrous (hydrogen fluoride) must be shipped in specification containers as follows:

(1) Spec. 3[2], 3A, 3AA, 3B, 3C, 3E, 4, 4A, 25[2], or 38[2], also spec. 4B, 4BA, or 4C if not brazed. Cylinders. Filling density must not exceed 85 percent of the pounds water weight capacity of the cylinder.

(2) Spec. 105A300-W, 105A400-W, 105[1], 105A500-W, or ARA-V[1], tank cars, equipped with special valves and appurtenances approved for this particular service. Filling density must not exceed 90 percent of the pounds water weight capacity of the tank.

(3) Spec. MC 310 and MC 311. Tank motor vehicles.

(4) Because of the present emergency and until further order of the Commission, samples of anhydrous hydrofluoric acid for laboratory examination are authorized for transportation by rail freight, rail express, or highway, when packed in aluminum cylinders, net capacity not exceeding 100 c. c., tested hydrostatically to 500 pounds per square inch and retested quinquennially, and shipped in strong wooden boxes. The cylinders must be cushioned so as to give proper protection to their valves. Filling density must not exceed 80 percent of the water-weight capacity of the cylinder.

(c) Containers must not be entirely filled. Unless otherwise provided in this part, sufficient outage (vacant space) must be allowed so that the liquid portion will not completely fill the container at 130°F. in order to prevent leakage or distortion of containers due to the expansion of the contents from increase in temperature during transit.

§ 73.265 **Hydrofluosilicic acid.** (a) Hydrofluosilicic acid must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside containers of natural rubber, ceresine, or other material of equal efficiency resistant to hydrofluosilicic acid

(2) Spec. 11A or 11B. Wooden barrels or kegs with inside containers of natural rubber or ceresine.

(3) Spec. 10A. Wooden barrels or kegs lined with asphaltum or other material of equal efficiency resistant to hydrofluosilicic acid.

(b) Hydrofluosilicic acid of not exceeding 40 percent strength may also be shipped when packed in specification containers as follows:

(1) Spec. 5D. Rubber-lined metal barrels or drums. Any barrel or drum that shows evidence of damage must be tested before shipment for defect in lining in the manner prescribed in spec. 5D.

(2) Spec. 43A. Rubber drums. Any drum showing evidence of damage must be tested to 20 pounds hydrostatic pressure, without leakage, before using.

(3) Spec. 103B or 103B-W. Tank cars, rubber-lined tanks.

(4) Spec. MC 310 and MC 311. Tank motor vehicles lined with rubber.

(c) Hydrofluosilicic acid containing no free hydrofluoric acid or other ingredient that will attack glass, may also be shipped when packed in specification containers as follows:

(1) Spec. 1A, 1C, 1D, or 1E. Carboys in boxes, in kegs, or plywood drums, for which the use of rubber stoppers and gaskets is also authorized.

(2) Spec. 1X. Boxed carboys of 5 to 6 gallons capacity; single-trip for export only. For shipment by common carriers by water to noncontiguous territories or possessions of the United States and foreign countries; shipments from inland points in the United States which are consigned to such destinations are authorized to be transported to ship side by rail freight in carload lots only and by motor vehicle in truckload lots only.

(3) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside glass containers, not over 1 gallon each, with rubber or ground-in glass stoppers properly secured.

(4) The vacant space in containers of these acids must be sufficient so that when raised to a uniform temperature of 130°F. the vapor pressure shall not exceed 6 pounds per square inch

(d) Hydrofluosilicic acid of not exceeding 32 percent strength may also be shipped when packed in specification containers as follows:

(1) Spec. 12B. Fiberboard boxes with inside containers of polyethylene, or other nonfragile plastic material resistant to the lading, not over 1 quart capacity each, suitably cushioned to prevent movement within the box. Gross weight of complete package must not exceed 65 pounds.

(2) Spec. 1F or 1G. Polyethylene carboys in plywood boxes or drums, or wooden boxes.

(3) Spec. 6J. Steel barrels or drums having inside spec. 2S polyethylene drum. Gross weight restriction indicated by the gross weight embossment in the steel barrel or drum shall be waived.

§ 73.266 **Hydrogen peroxide solution in water.** (a) Hydrogen peroxide solution in water containing over 52 percent hydrogen peroxide by weight must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside containers consisting of glass bottles not over 1 quart capacity each; bottles must have vented closure and must be packed in a metal container vented at bottom packed in another metal container vented at top; cushioning material shall be used between glass bottle and inner container and between inner and outer metal containers; cushioning material shall be vermiculite or equivalent in an amount at least 10 times the volume of the solution shipped and shall be wet with at least 10 percent water by volume to which has been added a stabilizing agent

(2) Spec. 42D. Aluminum drums with vented closure in top head; not over 30 gallons capacity; side openings not permitted. Closure must be sealed to prevent removal in transit and top head plainly marked, "KEEP THIS END UP" or "KEEP PLUG UP TO PREVENT SPILLAGE." For shipments other than carload or truckload lots loaded by consignor and unloaded by consignee drums must be of design and venting arrangement approved by the Bureau of Explosives.

(b) Hydrogen peroxide solution in water containing not over 52 percent hydrogen peroxide by weight must be packed in specfication containers as prescribed in paragraph (a) of this section or as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with glass or earthenware inside containers of not more than 1 gallon capacity each. Inside containers must be well cushioned. All material used for cushioning must be incombustible mineral matter, such as whiting, mineral wool, infusorial earth, asbestos, or sifted ashes. Cushioning of inside containers in outside wooden boxes by means of elastic packing, such as wooden strips or large corks fastened securely in position, is authorized if the completed package will pass the swing test prescribed for boxed carboys in spec. 1A.

(2) Spec. 34B. Aluminum carboys.

(3) Spec. 42D Aluminum drums with vented closure in top head; not over 55 gallons capacity. Closure must be sealed to prevent removal in transit and top head plainly marked "KEEP THIS END UP" or "KEEP PLUG UP TO PREVENT SPILLAGE." Aluminum drums of not over 30 gallons capacity already in service for the transportation of this material, manufactured prior to April 24,1934, and of at least equal strength and efficiency as drums of like capacity authorized under spec. 42D, may be continued in use until further order of the Commission.

(4) Spec. 42E. Aluminum drums (single-trip).

(c) Hydrogen peroxide solution in water containing over 8 percent hydrogen peroxide by weight and not exceeding 37 percent must be packed in specification containers as prescribed in paragraphs (a) or (b) of this section or as follows:

(1) Spec. 1A. Glass carboys. The cushioning must be incombustible mineral material, elastic wooden-strip packing, or large elastic cushions such as corks fastened securely in position. The use of hay, excelsior, ground cork, or similar material, whether treated or untreated, is prohibited. The carboy stoppers must be vented so as to prevent accumulation of internal pressure; use of cork gasket impregnated with paraffin is authorized.

(2) Spec. 1X. Boxed carboys of 5 to 6 gallons capacity; single-trip for export only. For shipment by common carriers by water to noncontiguous territories or possessions of the United States and foreign countries; shipments from inland points in the United States which are consigned to such destinations are authorized to be transported to ship side by rail freight in carload lots only and by motor vehicle in truckload lots only.

(3) Spec. 1D or 1E. Glass carboys in boxes or plywood drums of not over 6.5 gallons nominal capacity. Means shall be provided so that accumulated pressure in bottle shall not exceed 10 pounds p.s.i gauge at 130°F., or shall vent at a pressure not to exceed 10 pounds p.s.i gauge at 130°F., or shall vent at a pressure not to exceed 10 pounds p.s.i. gauge. The cushioning must be incombustible mineral material, elastic wood-strip packing, or large elastic cushions such as corks fastened securely in position. The use of hay, excelsior, ground cork, or similar material, whether treated or untreated, is prohibited.

(4) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside containers of polyethylene, or other plastic material resistant to the lading, not over 1 pint capacity or 16 ounces by weight each. Inside containers must be securely cushioned with incombustible mineral matter, such as whiting, mineral wool, infusorial earth, asbestos, or sifted ashes.

(5) Spec. 1F, 1G, or 1H, polyethylene carboys in wooden boxes, plywood drums, or metal crates. The carboy closures must be vented so as to prevent accumulation of internal pressure.

(6) Spec. 12B. Fiberboard boxes, with inside aluminum bottles constructed of at least 99 percent pure aluminum of not over 5 pounds or 5 pints capacity each. Each bottle shall be individually partitioned and surrounded by incombustible mineral packing material in the outside shipping container. Bottle closure shall be by means of a threaded aluminum cap, fitted with polyethylene gasket or other equally efficient closing device. A venting device which will not leak liquid under conditions normally incident to transportation is permitted.

(7) Spec. 6J. Steel barrels or drums having inside spec. 2S polyethylene drums Gross weight restriction indicated by the gross weight embossment in the steel barrel or drum is waived.

(d) Hydrogen peroxide solution in water containing over 8 percent hydrogen peroxide by weight and not exceeding 10 percent must be packed in specification containers as prescribed in paragraphs (a), (b), or (c) of this section or as follows:

(1) Spec. 10A. Wooden barrels, paraffined-lined.

(e) Hydrogen peroxide solution in water not exceeding 52 percent hydrogen peroxide by weight, when shipped in tank cars, tank motor vehicles, or portable tanks in carload or truckload quantities only, is not subject to any other requirement of Parts 71-78 and 197.

(f) Hydrogen peroxide solution in water exceeding 52 percent hydrogen peroxide by weight may also be packed in specification containers as follows:

(1) Spec. 103A-AL-W. Tank cars. Venting arrangement must be approved by the Bureau of Explosives.

(g) Hydrogen peroxide solution in water exceeding 52 percent hydrogen peroxide by weight may also be shipped in tank motor vehicles subject to Parts 71-78 provided that such shipments are for ultimate use of the Departments of the Army, Navy, and Air Force of the United States Government. Tank motor vehicles must be of design and venting arrangement approved by the Bureau of Explosives.

§ 73.267 **Mixed acid (nitric and sulfuric acid) (nitrating acid).** (a) Mixed acid (nitric and sulfuric acid) (nitrating acid), when offered for transportation by carriers by rail freight, highway, or water must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside glass bottles not over 7 pounds capacity each, individually inclosed in tightly closed metal cans and cushioned therein with incombustible mineral material.

(2) Spec. 5C. Metal barrels or drums of Type 304ELC or 347 stainless steel only. (See paragraph (b) of this section.)

(3) Spec. 103A or 103A-W. Tank cars. (See paragraph (b) of this section.)

(4) Spec. 1A or 1C. Carboys in boxes or kegs. Authorized only for mixed nitric and sulfuric acid containing not over 17 percent nitric acid and containing at least 33 per cent water. Straight-sided carboys must be used; cushioning must be incombustible mineral material, elastic wooden-strip packing, or large elastic cushions, such as cork, fastened securely in position. The use of hay, excelsior, ground cork, or similar material, whether treated or untreated, is prohibited.

(5) Spec. 1X. Boxed carboys of 5 to 6 gallons capacity; single-trip for export only. For shipment by common carriers by water to noncontiguous territories or possessions of the United States and foreign countries; shipments from inland points in the United States which are consigned to such destinations are authorized to be transported to ship side by rail freight in carload lots only and by motor vehicle in truckload lots only.

(6) Spec. 1D, or 1E. Glass carboys in boxes or plywood drums of not over 6.5 gallons nominal capacity; authorized only for mixed nitric and sulfuric acid, containing not over 17 percent nitric acid and containing at least 83 percent water; means shall be provided so that accumulated pressure in bottle shall not exceed 10 pounds per square inch gauge at 130° F., or vent at pressure not to exceed 10 pounds per square inch gauge. Cushioning must be incombustible mineral material, elastic wooden strip packing, or large elastic cushions such as cork, fastened securely in position. The use of hay, excelsior, ground cork, or similar material, whether treated or untreated, is prohibited.

(7) Spec. MC 310 and MC 311. Tank motor vehicles. (See paragraph (b) of this section.)

(8) Spec. 60. Portable tanks. (See paragraph (b) of this section.)

(9) Spec 5A. Carbon steel barrels or drums. Authorized only for mixed acids containing less than 80 percent nitric acid. (See paragraph (b) of this section.)

(b) Mixtures of sulfuric acid and nitric acid (nitrating acid), shipped in tank cars, cargo tanks, tanks trucks, or metal barrels or drums, shall contain not less than 10 percent sulfuric acid. These mixtures may contain:

(1) Up to 10 percent water with not less than 10 percent sulfuric acid.

(2) Up to 15 percent water with not less than 15 percent sulfuric acid.

(3) Up to 20 percent water with not less than 20 percent sulfuric acid.

(4) Up to 38 percent water with not less than 62 percent sulfuric acid.

(c) Mixed acid (nitric and sulfuric acid) (nitrating acid), when offered for transportation by rail express must be packed in specification containers as follows (also authorized for transportation by carriers by rail freight, highway, or water):

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside glass bottles with glass stoppers ground to fit, and these stoppers must be held in place by plaster of Paris covered by strong cloth securely tied. Glass bottles having necks with molded screw threads, must be closed by threaded-type acid-resistant plastic caps. Caps must be equipped with an elastic composition cushion and with glass, porcelain or similar liner which must be impervious to the acid. Such caps, when secured in place by at least one complete continuous thread, must be capable of preventing any leakage of the liquid.

(2) Or glass bottles having necks with molded screw threads must be closed by threaded-type acid-resistant caps. Caps must be lined with a resilient liner which must be impervious to the acid. Such caps, when secured in place by at least one complete continuous thread, must be capable of preventing any leakage of the acid.

(3) Each bottle must be placed in a tightly closed metal container and well cushioned therein on all sides with incombustible mineral packing material, such as whiting, mineral wool, infusorial earth (kieselguhr), asbestos, sifted ashes, or powdered china clay, etc The metal container must be packed in the outside container, and well cushioned by incombustible mineral packing material as herein described.

(4) Not more than 3½ pounds (1¼ quarts) of mixed acid may be shipped in one outside package.

§ 73.268 Nitric acid. (a) Nitric acid exceeding 40 percent concentration in any quantity must not be packed with any other article.

(b) Nitric acid in any concentration which does not contain significant quantities of sulfuric acid or hydrochloric acid as impurities, when offered for transportation by carriers by rail freight, highway, or water must be packed in specification containers as follows:

(1) Spec. 103C-W. Tank cars.

(3) Spec. MC 310 and MC 311. Tank motor vehicles.

(4) Spec. 5C. Metal barrels or drums. Authorized for concentrations or nitric acid as limited by § 78.83-3 (c). Containers weightng less than 85 percent of their original marked weight are not authorized. Spec. 5C, drums already in service for transportation of this material, manufactured prior to October 1, 1949, may be continued in service within the above limitations until further order of the Commission.

(c) Nitric acid of 80 percent or greater concentration which does not contain significant quantities of sulfuric acid or hydrochloric acid as impurities, when offered for transportation by carriers by rail freight, highway, or water must be packed in specification containers as follows:

(1) Spec. 42B or 5X; also 42,[1] if made and marked prior to October 1, 1930. Aluminum drums, or aluminum-lined steel drums.

(2) Spec. 103A-AL-W. Tank car.

(d) Nitric acid of 90 percent or greater concentration when offered for transportation by carriers by rail freight, highway, or water must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, 19A, 11A, or 11B. Wooden boxes, barrels and kegs with inside containers which must be glass bottles not over 5 pints capacity each, individually inclosed in tightly closed metal cans and cushioned therein with sufficient incombustible mineral material. (See paragraphs (g) and (h) of this section.)

(e) Nitric acid of concentration of less than 90 percent when offered for transporation by rail freight, highway, or water must be packed in specification containers as follows:

(1) Spec 15A, 15B, 15C, 16A, 19A, 11A, or 11B. Wooden boxes, barrels and kegs with inside containers which must be glass bottles not over 5 pints capacity each. See paragraphs (g) and (h) of this section.)

(f) Nitric acid of concentration of 72 percent or less, when offered for transportation by rail freight, highway, or water must be packed in specification containers as follows:

(1) Spec. 1A or 1C. Straight sided carboys in boxes or kegs.

(2) Spec. 1X. Boxed carboys of 5 to 6 gallons capacity; single-trip for export only. For shipment by common carriers by water to noncontiguous territories or possessions of the United States and foreign countries; shipments from inland points in the United States which are consigned to such destinations are authorized to be transported to ship side by rail freight in carload lots only and by motor vehicle in truckload lots only.

(3) Spec. 1D, or 1E. Glass carboys in boxes or plywood drums of not over 6.5 gallons nominal capacity. Means shall be provided so that accumulated pressure in bottle shall not exceed 10 pounds per square inch gauge at 130° F., or shall vent at a pressure not to exceed 10 pounds per square inch gauge.

(4) Cushioning for carboys must be incombustible mineral material, elastic wooden strips, natural cork blocks or rubber blocks. Other materials may be used if approved by the Bureau of Explosives The use of hay, excelsior, loose ground cork, or similar materials, whether treated or untreated, is prohibited.

(g) Closures for bottles. Glass stoppers ground to fit and held in place by plaster of Paris covered by a strong cloth securely tied; or:

(1) Threaded-type acid-resistant caps with gasket or lining impervious to the acid and sufficiently resilient, or cushioned, to give an acidproof closure; at least 1 complete continuous thread is required to be engaged when bottle is closed for shipment.

(h) Cushioning inside containers. Inside containers must be well cushioned. All material for cushioning must be incombustible mineral material, such as whiting, mineral wool, infusorial earth, asbestos, sifted ashes, etc. The use of hay, excelsior, ground cork, or similar material, whether treated or untreated, is prohibited. Where the cushioning material is very fine or powdery, separate partitions for the individual inside containers shall be provided to prevent the bottles from shifting and coming in contact with each other, and the box must be tight to prevent sifting of cushioning material.

(1) Cushioning of inside containers in outside specification wooden boxes by means of elastic packings, such as wooden strips or large corks fastened secured in position, is authorized if the completed package will pass the swing test prescribed for boxed carboys, in spec. 1A.

(i) Nitric acid of any concentration, when offered for transportation by rail express, must be packed in specification containers as follows (also authorized for transportation by carriers by rail, freight, highway, or water):

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside glass bottles with glass stoppers ground to fit, and these stoppers must be held in place by plaster of Paris covered by strong cloth securely tied. Glass bottles having necks with molded screw threads, must be closed by threaded-type acid-resistant plastic caps. Caps must be equipped with an elastic composition cushion and with glass porcelain or similar liner which must be impervious to the acid. Such caps, when secured in place by at least one complete continuous thread, must be capable of preventing any leakage of the acid.

(2) Or glass bottles having necks with molded screw threads must be closed by thread-type acid-resistant caps Caps must be lined with a resilient liner which must be impervious to the acid. Such caps, when secured in place by at least one complete continuous thread, must be capable of preventing any leakage of the acid.

(3) Each bottle must be placed in a tightly closed metal container, and well cushioned therein on all sides with incombustible mineral packing material, such as whiting, mineral wool, infusorial earth (kieselguhr), asbestos, sifted ashes, or powdered china clay, etc. The metal container must be packed in outside containers, and well cushioned by incombustible mineral packing material as described in this section.

(4) Not more than 5 pints of nitric acid shall be shipped in one outside package.

(j) Nitric acid of not over 50 percent concentration, when offered for transportation by rail express, may in addition to the provisions of paragraph (i) of this section be packed in specification containers as follows (also authorized for transportation by carriers by rail freight, highway, or water):

(1) Spec. 15A, 15B, 15C, 16A, 19A, or 12B. Wooden or fiberboard boxes with not over 12 inside glass ampoules having capacity not over 4 fluid ounces each. Each glass ampoule must be well cushioned with incombustible mineral packing material, such as vermiculite or other equally efficient material, and be packed in a cylindrical cardboard tube having wall thickness of at least ⅛ inch, with the inside coated with wax, and be equipped with metal bottom and with metal screw-cap top. The inside packages must be separated by efficient means.

§ 73.269 **Perchloric acid.** (a) Perchloric acid in excess of 72 percent must not be shipped. When not exceeding 72 percent strength must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with glass inside containers consisting of glass bottles not over 7 pounds capacity each cushioned with incombustible mineral material in amount sufficient to absorb the acid.

(2) Spec 1A, 1C, 1D, or 1E. Glass carboys, in boxes, kegs or plywood drums.

(3) Spec. 1X. Boxed carboys or 5 to 6 gallons capacity; single-trip for export only. For shipment by common carriers by water to noncontiguous territories or possessions of the United States and foreign countries; shipments from inland points in the United States which are consigned to such destinations are authorized to be transported to ship side by rail freight in carload lots only and by motor vehicle in truckload lots only.

(b) Cushioning for carboys must be incombustible mineral material, elastic wooden strips, natural cork blocks or rubber blocks. Other materials may be used if approved by the Bureau of Explosives. The use of hay, excelsior, loose ground cork, or similar materials, whether treated or untreated, is prohibited.

(c) Perchloric acid in any quantity must not be packed with any other article.

(d) Closures for bottles. Required as follows:

(1) Glass stoppers ground to fit and held in place by plaster of Paris covered by a strong cloth securely tied.

(2) Threaded-type acid-resistant caps with a gasket or lining impervious to the acid and sufficiently resilient, or cushioned, to give an acid-proof closure; at least one complete continuous thread is required to be engaged when bottle is closed for shipment.

(e) Inside containers must be well cushioned. All material for cushioning must be incombustible mineral material, such as whiting, mineral wool, infusorial earth (kieselguhr), asbestos, sifted ashes, or powdered china clay, etc. The use of hay, excelsior, ground cork, or similar material, either treated or untreated, is prohibited. Where the cushioning material is very fine or powdery, separate partitions for the individual inside containers should be provided to prevent the bottles from shifting and coming in contact with each other, and the box must be tight to prevent sifting of cushioning material.

(1) Cushioning of inside containers in outside wooden boxes by means of elastic packings, such as wooden strips or large corks fastened securely in position, is authorized if the completed package will pass the swing test prescribed for boxed carboys, in spec. 1A.

§ 73.270 **Phosphorus tribromide.** (a) Phosphorus tribromide must be packed in specification containers as follows:

(1) Spec. 5H. Lead-lined metal barrels or drums.

(2) Spec. 11A or 11B. Wooden barrels or kegs with glass or earthenware inside containers not over 2 gallons each; the glass or earthenware containers must be cushioned in the outside containers by means of incombustible elastic packing material of such nature that a mixture of the liquid and the packing material will not cause fires or heating.

(3) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with glass or earthenware inside containers not over 1 gallon each, except that inside containers up to 3 gallons each are authorized when only one is packed in an outside container.

(4) Spec. 28. Metal-jacketed lead carboys.

§ 73.271 **Phosphorus oxychloride, phosphorus trichloride, and thiophosphoryl chloride.** (a) Phosphorus oxychloride, phosphorus trichloride and thiophosphoryl chloride must be packed in specification containers as follows:

(1) Spec. 5H. Lead-lined metal barrels or drums.

(2) Spec. 5K. Nickel drums.

(3) Spec. 11A or 11B. Wooden barrels or kegs with glass or earthenware inside containers not over 2 gallons each; the glass or earthenware containers must be cushioned in the outside containers by means of incombustible elastic packing material of such nature that a mixture of the liquid and the packing material will not cause fire or heating.

(4) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with glass or earthenware inside containers not over 1 gallon each, except that inside containers up to 3 gallons each are authorized when only one is packed in an outside container.

(5) Spec. 28. Metal-jacketed lead carboys.

(6) Spec. 60. Portable tanks when tanks are lead-lined.

(7) Spec. 103A, 103A-W, or 103A-N-W. Tank cars, when the tanks of these cars are lead-lined or the tanks

are made of solid nickel at least 99 percent pure and all cast metal parts of the tank in contact with the lading have a minimum nickel content or approximately 96.7 percent.

(8) Spec. MC 310 and MC 311. Tank motor vehicles when tanks are lead-lined or nickel-lined. If nickel-lined, the lining shall comprise at least 1/32 inch of uncontaminated nickel at all points including rivets, welds and other joints, and edges of tank plates.

(9) Spec. 103A or 103A-W. Tank cars. Spec. 103A tanks must be of steel at least 10 percent nickel clad and Spec. 103A-W tanks must be of steel at least 20 percent nickel clad.

(10) Spec. 103E-W. Tank cars made from type 316 stainless steel. Authorized for phosphorus trichloride and thiophosphoryl chloride only.

(b) Phosphorus trichloride and thiophosphoryl chloride may also be shipped in metal barrels or drums, Spec. 5A or 5C.

(c) Spec. 5C, metal barrels or drums. Authorized for phosphorus trichloride only.

(d) Spec. MC 310 or MC 311. Tank motor vehicles when tanks are clad with 20 percent type 316 stainless steel. Authorized for phosphorus oxychloride only.

§ 73.272 **Sulfuric acid.** (a) Sulfuric acid (oleum, oil of vitriol, etc.) must be packed in specification containers as follows:

(b) Sulphuric acid solutions of not over 25 percent concentrations, in inside containers of not more than 8 ounces capacity each, resistant to the lading, packed in strong outside containers and cushioned with absorbent material in sufficient quantity to completely absorb liquid contents in event of breakage, are exempt from specification packaging, marking, and labeling requirements, except that marking name of contents on outside container is required for shipments via carrier by water. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C C. Motor Carrier Safety Regulations.

(c) Sulfuric acid of any concentration:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with glass or earthenware inside containers, not over one gallon capacity each, except that such containers up to three gallons capacity may be used when only one such container is packed in each outside wooden box.

(2) Spec. 31. Jugs in tubs.

(3) Spec. 11A or 11B. Wooden barrels or kegs with glass or earthenware inside containers not over 2 gallons capacity each.

(4) Spec. 1X. Boxed carboys of 5 to 6 gallons capacity; single-trip for export only. For shipment by common carriers by water to noncontiguous territories or possessions of the United States and foreign countries; shipments from inland points in the United States which are consigned to such destinations are authorized to be transported to ship side by rail freight in carload lots only, and by motor vehicle in truckload lots only.

(5) Spec. 22A or 22B. Wooden drums, glued plywood, with not more than 1 inside container of glass or earthenware not over 1-gallon capacity.

(d) For sulfuric acid of concentrations not less than 100 percent and not more than 115 percent (approximate):

(1) Spec. 5C. Metal barrels or drums of Type 304, 316, or 347 stainless steel or other types of stainless steel of equivalent corrosion resistance and physical properties.

(e) For sulfuric acid of concentrations not to exceed 100.5 percent:

(1) Spec. 1A or 1C. Carboys in boxes or kegs.

(2) Spec. 1D or 1E. Glass carboys in boxes or plywood drums, of not over 6.5 gallons nominal capacity.

(f) For sulfuric acid of concentrations not to exceed 95 percent (approximately 1.835 specific gravity) (66° Baume):

(1) Spec. 5H. Metal barrels or drums.

(2) Spec. 1F or 1G. Polyethylene carboys in wooden boxes, plywood drums or boxes.

(g) For sulfuric acid of concentrations 77.5 percent (approximately 1.7019 specific gravity) (59.8° Baume) or greater concentrations with or without an inhibitor provided such acid has a corrosive effect on steel measured at 100° F. no greater than 66° Baume commercial sulfuric acid:

(1) Spec. 5A or 5C. Metal barrels or drums. Spec. 5C metal barrels or drums must be of types 304, 316, or 347 stainless steel and are authorized only for sulfuric acid of 93 percent or greater strength.

NOTE 1: Tapered steel plugs, without gaskets, for standard spec. 5A flanges are authorized Threaded length must not be less than 1½ inches. Major diameter of plug not to exceed 2 11/32 inches and minor diameter not less than 2 7/32 inches.

(2) Spec. 17F. Metal barrels or drums (single-trip only). Drums equipped with vented closures of an experimental type approved by the Bureau of Explosives are also authorized for export shipments.

(h) For sulfuric acid of concentrations 65.25 percent (approximately 1.559 specific gravity) (52° Baume) or greater concentrations, provided the corrosive effect in steel measured at 100° F. is not greater than that of 52° Baume commercial sulfuric acid:

(1) Spec. 60. Portable tank.

(2) Spec. MC 310 and MC 311. Tank motor vehicles.

(3) Spec. 103A or 103A-W. Tank cars. Sulfuric acid, except oleum, mixed acid (nitric and sulfuric) (nitrating acid), and other fuming acids, may be transported in ICC-103A tank cars having safety vents equipped with lead discs having a ⅛ inch breather hole in the center thereof.

(i) For sulfuric acid of concentrations not to exceed 51 percent (approximately 1.408 specific gravity) (42° Baume), unless otherwise provided:

(1) Spec. 5D. Rubber-lined metal drums.

(2) Spec. 60. Portable tanks (rubber-lined).

(3) Spec MC 310 and MC 311. Tank motor vehicles (rubber-lined).

(4) Spec. 103B or 103B-W. Tank cars.

(5) Spec. 1F, 1G, or 1H. Polyethylene carboys in wooden boxes, plywood drums or boxes, or metal crates.

(6) Spec. 6J. Steel barrels or drums having inside spec. 2S polyethylene drum. Authorized for sulfuric acid concentrations not over 76 percent. Gross weight restrictions indicated by the gross weight embossment in the steel barrel or drum shall be waived.

(j) Gaskets must be in a plastic condition when applied to carboys in boxes, barrels or kegs containing water-white sulfuric acid (electrolyte grade) of concentrations 77.5 percent (approximately 1.7019 specific gravity) (59.8° Baume).

(k) Soft rubber gaskets are authorized on carboys in boxes, barrels or kegs containing sulfuric acid of not over 51 percent concentrations (approximately 1.408 specific gravity) (42° Baume).

(l) Because of the present emergency and until further order of the Commission, sulfuric acid may be offered in transportation by carriers by water in conformity with Regulations for Explosives or Other Dangerous Articles on Board Vessels, 46 CFR 146.23-10, issued by the Commandant of the Coast Guard.

§ 73.273 **Sulfur trioxide, stabilized.** (a) Sulfur trioxide, stabilized, must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with glass or earthenware inside containers not over 1 gallon each.

(2) Spec. 5A or 5C. Metal barrels or drums, not over 55 gallons capacity each.

(3) Spec. 17F. Metal drums (single-trip).

(4) Spec 103A or 103A-W. Tank cars. Authorized only for stabilized sulfur trioxide. Cars equipped with interior heater coils not permitted.

§ 73.274 **Fluosulfonic acid.** (a) Fluosulfonic acid must be packed in containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside containers which must be not over 1 gallon each, except that inside containers up to 3 gallons are authorized when only one is packed in each outside container, as prescribed in Notes 1 and 2 to this section.

NOTE 1: Pyrex glass bottles, authorized only for material containing an excess of sulfur trioxide, with Pyrex glass stoppers ground to fit and held in place by plaster of Paris covered by strong cloth securely tied; each bottle must be placed in a metal container, well cushioned therein with incombustible absorbent materials such as mineral wool, infusorial earth (kieselguhr), asbestos, etc.;

NOTE 2: Or steel containers, 14 gauge steel throughout, welded heads and side seams, equipped with ¾ inch welded flange and plug. Threads for plug must be 8 or less per inch. Each drum must be tested for leakage with 15 pounds hydrostatic pressure.

(2) Spec. 5A. Metal barrels or drums not over 55 gallons capacity each.

(3) Spec. 103A or 103A-W. Tank cars.

§ 73.275 **Difluorophosphoric acid, anhydrous, monofluorophosphoric acid, anhydrous, hexafluorophosphoric acid, and mixtures thereof.** (a) Difluorophosphoric acid anhydrous, monofluorophosphoric acid, anhydrous, hexafluorophosphoric acid, and mixtures thereof must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A wooden boxes, spec. 12B fiberboard boxes, or spec. 21A or 21B fiber drums with inside containers which must be polyethylene, or other non-fragile plastic bottles resistant to the lading, not over 2 gallons capacity each, closed by means of threaded acid-resistant caps; caps must have at least one complete continuous thread and be additionally sealed to the bottle to prevent turning of cap after bottle is closed for shipment.

(2) Spec. 42B, 42C, or 42D. Aluminum drums not over 55 gallons capacity.

(3) Spec. 1F. Polyethylene carboys in plywood drums.

(4) Spec. 60. Portable tanks Authorized for inhibited acids enumerated in paragraph (a) only.

(b) Inside containers must be packed so they cannot change position in the outside container while in transit and inert absorbent cushioning material must be used where necessary.

§ 73.276 **Anhydrous hydrazine and hydrazine solution.** (a) Anhydrous hydrazine and hydrazine solution containing 50 per cent or less of water must be packed in specification containers as follows:

(1) Spec. 1D. Boxed glass carboys.

(2) Spec. 15A, 15B, or 15C. Wooden boxes with inside containers which must consist of glass bottles not exceeding 1-gallon capacity each, cushioned by means of vermiculite within tin cans which shall be tightly closed.

(3) Spec. 5, 5A, 5C, or 17E (single-trip). Metal barrels or drums which shall be of type 304 or 347 stainless steel, with openings not exceeding 2.3 inches in diameter.

§ 73.277 **Hypochlorite solutions.** (a) Hypochlorite solutions containing more than 7 percent available chlorine by weight must be packed in specfiication containers as follows:

(1) Spec. 15A, 15B, 15C, or 12B. Wooden or fiberboard boxes with glass or earthenware inside containers of not more than 1 gallon capacity each. Packages must not weigh over 65 pounds gross nor contain more than 4 such inside containers if their capacity is greater than 5 pints each.

(2) Spec. 1A, 1C, 1D, or 1E. Glass carboys in boxes, kegs, or plywood drums.

(3) Spec. 1F, 1G, or 1H. Polyethylene carboys in wooden boxes, plywood drums or boxes, or metal crates. Authorized for sodium hypochlorite solution not over 16 percent strength only.

(4) Spec. 6J. Steel barrels or drums having inside spec. 2S polyethylene drum. Gross weight restriction indicated by the gross weight embossment in the steel barrel or drum shall be waived. Authorized for not over 16 percent sodium hypochlorite solution only.

(b) Closures for inside containers and carboys must be vented and must be of a material resistant to the lading and capable of preventing leakage of liquid contents.

(c) Containers of 5 gallons capacity and over, of a type in service for transportation of this material prior to September 1, 1948, and of a design and venting arrangement approved by the Bureau of Explosives, may be continued in use until further order of the Commission.

(d) Glass or earthenware containers of not more than 4-fluid ounces capacity each, packed in strong outside containers, and cushioned with absorbent material in sufficient quantity to completely absorb liquid contents in the event of breakage, are exempt from specification packaging, marking, and labeling requirements, except that marking name of contents on outside container is required for shipments via carrier by water. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

(e) Shipments by tank motor vehicle are not subject to any other requirement of Parts 71-78 and 197.

§ 73.278 **Nitrohydrochloric acid.** (a) Nitrohydrochloric acid, which is a mixture of nitric acid not over 1.42 specific gravity and hydrochloric acid not over 1.19 specific gravity in the approximate proportions of one part nitric acid and three parts hydrochloric acid, must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A or 19A. Wooden boxes with glass inside containers of not over 5 pints capacity each, individually inclosed in tightly closed metal cans and cushioned therein with sufficient incombustible mineral material.

(b) Nitrohydrochloric acid diluted, is a solution of nitrohydrochloric acid as described in paragraph (a) of this section, which has been diluted to not less than five times the volume of water and must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with glass inside containers of not over 5 pints capacity each, individually inclosed in tightly closed metal cans and cushioned therein with sufficient incombustible mineral material.

(2) Spec. 1A, 1D, or 1E. Glass carboys in boxes or plywood drums, not over 5 gallons nominal capacity for spec. 1A and not over 6.5 gallons nominal capacity for spec. 1D and 1E.

§ 73.279 **Anisoyl chloride.** (a) Anisoyl chloride must be packed in specification containers as follows:

(1) Spec. 5C. Metal barrels or drums.

(2) Spec. 5. Metal barrels or drums of stainless steel only, with flanges for closures welded in place and having no opening exceeding 2.3 inches in diameter.

(b) Inside containers of not more than 8-fluid ounces capacity each, resistant to lading, packed in strong outside containers, and cushioned with absorbent material in sufficient quantity to completely absorb liquid contents in the event of breakage, are exempt from specification packaging, marking and labeling requirements, except that marking name of contents on outside container is required for shipments via carrier by water. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

§ **73.280 Allyl trichlorosilane, amyl trichlorosilane, butyl trichlorosilane, cyclohexenyl trichlorosilane, cyclohexyl trichlorosilane, diethyl dichlorosilane, diphenyl dichlorosilane, dodecyl trichlorosilane, ethyl phenyl dichlorosilane, hexadecyl trichlorosilane, hexyl trichlorosilane, nonyl trichlorosilane, octadecyl trichlorosilane, octyl trichlorosilane, phenyl trichlorosilane, and propyl trichlorosilane.** (a) Allyl trichlorosilane, amyl trichlorosilane, butyl trichlorosilane, cyclohexenyl trichlorosilane, cyclohexyl trichlorosilane, diethyl dichlorosilane, diphenyl dichlorosilane, dodecyl trichlorosilane, ethyl phenyl dichlorosilane, hexadecyl trichlorosilane, hexyl trichlorosilane, nonyl trichlorosilane, octadecyl trichlorosilane, octyl trichlorosilane, phenyl tricholorsilane, and propyl trichlorosilane must be packed in specification containers as follows:

(1) Spec. 15A or 16B. Wooden boxes with glass inside containers not over 1 gallon capacity each securely closed and cushioned with incombustible absorbent material.

(2) Spec. 17H or 37A. Metal drums (single-trip), with glass inside containers not over 1 gallon capacity each securely closed and cushioned with incombustible absorbent material

(3) Spec. 5A. Metal drums not over 55 gallons capacity.

(4) Spec. 5F. Metal drums not over 11 gallons capacity.

(5) Spec. 5, 5B, 5C, and 17E single-trip. Metal drums. These containers not authorized for shipments by rail express.

(6) Specification cylinders as prescribed for any compressed gas, except acetylene.

(7) Spec. 103, 103A, 105A100, or 105A100-W. Tank cars.

(8) Spec. MC 310 or MC 311. Tank motor vehicles of steel or stainless steel construction.

§ **73.281 a-Bromotoluene (benzyl bromide).** (a) a-Bromotoluene (benzyl bromide) must be packed in specification containers as follows:

(1) Spec. 15A, 15B, or 15C. Wooden boxes, with inside containers which must be glass bottles, not over 5 pints capacity each, closed by means of screw caps which are resistant to action of the contents; bottles must be packed in metal cans having slip-on or friction closure; cans must be cushioned in outside boxes with incombustible material.

§ **73.282 Isopropyl percarbonate, stabilized.** (a) Isopropyl percarbonate, stabilized, must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A or 19A. Wooden boxes with glass or earthenware inside containers of not over 2 gallons capacity each which must be maintained at a temperature below 75°F. Shipments are authorized for transportation by private or contract carrier by motor vehicle only.

§ **73.283 Bromine trifluoride.** (a) Bromine trifluoride must be packed in specification containers as follows:

(1) Spec. 3A150, 3AA150, 3E1800, 3B240, or 4B240. Cylinders.

§ **73.284 Bromine pentafluoride.** (a) Bromine pentafluoride—when offered for transportation by carriers by rail freight, highway, or water, must be packed in specification containers as follows:

(1) Spec. 3A150, 3AA150, 3E1800, or 4B240. Cylinders not over 120 pounds water capacity (nominal), filled to not over 210 percent of water capacity. Cylinders must be plugged and fitted with valve protection caps. Spec. 3E1800 cylinders must be packed in strong outside wooden boxes and contain not more than one pound of bromine pentafluoride.

(b) Bromine pentafluoride, when offered for transportation by rail express must be packed in specification containers as follows:

(1) Spec. 3A150, 3AA150, 3E1800, or 4B240. Cylinders containing not more than one pound of bromine pentafluoride. Cylinders must be plugged and fitted with valve protection caps and must be packed in strong outside wooden boxes.

§ **73.285 Chlorine trifluoride.** (a) Chlorine trifluoride must be packed in specification containers as follows:

(1) Spec. 3A150, 3AA150, 3E1800, 3B240, 4B240, or 4BA240, cylinders.

(2) Not more than 10 pounds of chlorine trifluoride may, in addition to the provisions of subparagraph (a) (1) of this section, be packed in cylinders equal to or of greater efficiency than those prescribed in subparagraph (a) (1) of this section when approved by the Bureau of Explosives.

§ **73.286 Chemical kits.** (a) Chemical kits, except as otherwise provided in Parts 71-78, must be packed, marked and labeled as prescribed by this part for the specific acids or corrosive liquids contained therein.

(b) Chemical kits containing acids in inside containers not exceeding 6-fluid ounces capacity each and complying with all of the following requirements, are exempt from specification packaging, marking other than name of contents, and labeling requirements Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

(1) The kit must not contain any of the items named in § 73.244 (c) of this part.

(2) The kit must be a strong wooden or metal container, or must be packed in a strong wooden or metal container.

(3) The acids or corrosive liquids must be cushioned with sufficient absorbent cushioning material to completely absorb the contents of the individual containers, and must be protected from injury by other materials in the kit.

(4) The contents of the kit must be of such nature and/or so packed that there will be no possibility of the mixture of contents causing dangerous evolution of heat or gas.

§ **73.287 Chromic acid solution.** (a) Chromic acid solution must be packed in specification containers as follows:

(1) In containers prescribed in § 73.245 of this part.

(2) Spec. 17H. Metal drums (single-trip), not over 5 gallons capacity.

(3) Spec. 12B. Fiberboard boxes with one inside glass container of capacity not over 4 fluid ounces, packed in a wax-lined cylindrical fiber carton with metal ends; bottle must have ground glass stopper securely held in position by a piece of cloth tied with wire and dipped in paraffin; space between bottle and the inner surface of the fiber cylinder must be filled with closely packed asbestos in sufficient quantity to completely absorb contents of bottle in the event of breakage. Use of this container will be permitted because of the present emergency and until further order of the Commission.

§ **73.288 Allyl chloroformate, benzyl chloroformate, ethyl chloroformate, and methyl chloroformate.** (a) Allyl chloroformate, benzyl chloroformate, ethyl chloroformate, and methyl chloroformate must be packed in specification containers as follows:

(1) Spec. 15A, 15B, or 15C. Wooden boxes with glass inside containers not over 1 pint each, cushioned with incombustible mineral material.

(2) Spec. 1A. Boxed carboys. Glass bottles having nominal capacity of 3 gallons also authorized when packed and tested in accordance with requirements of spec. 1A; necks must be protected during shipment.

(b) Allyl chloroformate may, in addition, be packed in specification 5H lead-lined metal drums not over 55 gallons capacity.

§ 73.289 Formic acid and formic acid solutions. (a) Formic acid and formic acid solutions must be packed in specification containers as follows:

(1) In containers prescribed in § 73.245, except spec. 5A. Metal barrels or drums.

(2) Spec. 103C-W or 103E-W. Tank cars. Spec. 103E-W tanks must be of type 316 stainless steel and must be stenciled "FOR FORMIC ACID ONLY."

(3) Spec. 10A. Wooden barrels or kegs, lined with latex rubber.

(4) Spec. MC310 and MC311. Tank motor vehicles.

(5) Spec 5C. Metal barrels or drums.

(6) Spec. 5. Metal barrels or drums of stainless steel only, with flanges for closures welded in place and having no opening exceeding 2.3 inches in diameter.

(7) Spec. 17H. Metal drums (single-trip) equipped with bag type liners of material and construction approved by the Bureau of Explosives. Each drum must have two diametrically opposite vent holes ¼ inch diameter in the side wall at each end in close proximity to the top curl and bottom chime. Interior of welded side seam must be covered or otherwise treated to provide a nonabrasive surface.

(8) Spec. 60. Portable tanks, marked "FOR FORMIC ACID ONLY."

(9) Spec. 1EX. Carboys in plywood drums.

(10) Spec. 1F, 1G, or 1H. Polyethylene carboys in wooden boxes, plywood drums or boxes, or metal crates.

(11) Spec. 6J. Steel barrels or drums having inside spec. 2S polyethylene drum. Gross weight restriction indicated by the gross weight embossment in the steel barrel or drum shall be waived.

§ 73.290 Mixtures of hydrofluoric and sulfuric acid. (a) Mixtures of hydrofluoric acid and sulfuric acid, containing not more than 80 percent by weight and not less than 70 percent by weight of hydrofluoric acid and sulfuric acid combined, with the hydrofluoric acid content not less than 25 percent by weight in any case, must be packed in specification containers as follows:

(1) Specification 5A. Unlined metal barrels or drums which have been subjected to an adequate passification or neutralization process (see note 1). Containers must be filled to not over 80 percent of capacity at 68°F. If containers are washed out with water, they must be repassified before shipment.

NOTE 1: Each metal container, before being put into this service, must be passified by the following or an equally efficient method: By filling drum to 90 percent of capacity with hydrofluric acid of 58 percent strength and allowing drum to stand 48 hours at a temperature of 80°F., and then 7 hours at 140°F., the internal pressure maintained at atmospheric pressure by means of a ventilated bung.

(2) Containers not exceeding 55 gallons capacity each are authorized for carload, truckload, less-than-carload, and less-than-truckload shipment Containers exceeding 55 gallons capacity each are authorized for carload or truckload shipments only but they must be loaded by consignor and unloaded by consignee.

(3) For less-than-carload or less-than-truckload shipments, containers must be of metal at least as heavy as 14 gauge United States standard for not over 20 gallons capacity each or 12 gauge for not over 55 gallons capacity each. Each container must be subjected to at least one of the following tests before shipment: By interior pressure of at least 15 pounds per square inch before filling or by holding for inspection for at least 24 hours after filling. In either case, each container must be vented prior to shipment.

§ 73.291 Flame retardant compound, liquid. (a) Flame retardant compound, liquid, must be packed in specification containers as follows:

(1) Spec. 1A, 1B, or 1C. Carboys in boxes or kegs which must be closed, and when reused must be reconditioned and tested, as provided in the specification.

(2) Spec. 1D, or 1E. Glass carboys in boxes or plywood drums of not over 6.5 gallons nominal capacity. Means shall be provided so that accumulated pressure in bottle shall not exceed 10 pounds per square inch gauge at 130°F., or shall vent at a pressure not to exceed 10 pounds per square inch gauge.

(3) Spec. 1X. Boxed carboys of 5 to 6 gallons capacity, single-trip for export only. For shipment by common carriers by water to noncontiguous territories or possessions of the United States and foreign countries; shipments from inland points in the United States which are consigned to such destinations are authorized to be transported to ship side by rail in freight carload lots only and by motor vehicle in truckload lots only.

(4) Spec. 10A. Wooden barrels or kegs, lined with asphalt or rubber.

(5) Spec. 11A or 11B. Wooden barrels or kegs with inside containers which must be glass or earthenware, not over 2 gallons each.

(6) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside containers which must be glass or earthenware, not over 1 gallon each, except that inside containers up to 3 gallons are authorized when only one is packed in each outside container.

(7) Spec. 28. Metal-jacketed lead carboys.

(8) Spec. 103B or 103B-W. Tank cars.

§ 73.292 Hexamethylene diamine solution. (a) Hexamethylene diamine solution must be packed in specification containers as follows:

(1) In containers prescribed in § 73.249.

(2) Spec. MC 300, MC 301, MC 302, MC 303, MC 310 or MC 311. Tank motor vehicles.

§ 73.293 Iodine monochloride. (a) Iodine monochloride must be packed in specification containers as follows:

(1) Spec. 15A or 15B. Wooden boxes with inside containers not over 1 quart capacity each; or with stone or earthenware jugs not over 1 gallon capacity each.

(b) Outage (vacant space above liquid) for inside containers must be not less than 15 percent.

(c) Inside containers must be securely closed by hermetically sealing or by glass or stone stoppers ground to fit and securely fastened or by screw caps fitted with gaskets of suitable material resistant to the contents.

(d) Inside containers must be securely cushioned on all sides with incombustible cushioning material which will not produce heat when in contact with iodine monochloride.

§ 73.294 Monochloroacetic acid, liquid. (a) Monocloroacetic acid, liquid, must be packed in specification containers as follows:

(1) In containers prescribed in § 73.245 (a) (1), (2), (3), (6), or (7).

(2) Spec. 103-N-W or 103A-W. Tanks cars. 103A-W tank cars must be nickel clad at least 20 percent.

(3) Spec. MC 310 and MC 311. Tank motor vehicles. Tanks must be made from Type 316 stainless steel or be suitably lined.

SUBPART F—COMPRESSED GASES; DEFINITION AND PREPARATION

§ 73.300 Compressed gases; definition. (a) A compressed gas for the purposes of Parts 71-78 is defined as any material or mixture having in the container either an absolute pressure exceeding 40 pounds per square inch at 70°F., or an absolute pressure exceeding 104 pounds per square inch at 130°F., or both; or any liquid flammable material having a Reid (Note 1) vapor pressure exceeding 40 pounds per square inch absolute at 100°F. (See § 73.326 for gases defined and classified as poisonous.)

(b) Any compressed gas as defined in paragraph (a) of this section shall be classified as a flammable compressed gas if any one of the following occurs:

(1) If either a mixture of 13 percent or less (by volume) with air forms a flammable mixture (Note 2) or the flammability range (Note 2) with air is greater than 12 percent regardless of the lower limit.

(2) Using the Bureau of Explosives' Flame Projection Apparatus, (see Note 3) the flame projects more than 18 inches beyond the ignition source with valve opened fully, or, the flame flashes back and burns at the valve with any degree of valve opening.

(3) Using the Bureau of Explosives' Open Drum Apparatus, (see Note 3) there is any significant propagation of flame away from the ignition source.

(4) Using the Bureau of Explosives' Closed Drum Apparatus, (see Note 3) there is any explosion of the vapor-air mixture in the drum.

NOTE 1. American Society for Testing Materials Method of Test for Vapor Pressure of Petroleum Products (D-323).

NOTE 2. These limits shall be determined at atmospheric temperature and pressure. The method of sampling and the test procedure shall be acceptable to the Bureau of Explosives. The flammability range is defined as the difference between the minimum and maximum percentage by volume of the material in mixture with air that forms a flammable mixture.

NOTE 3. A description of the Bureau of Explosives' Flame Projection Apparatus, Open Drum Apparatus, and Closed Drum Apparatus and method of tests may be procured from the Bureau of Explosives, 30 Vesey Street, New York 7, New York.

§ 73.301 **General requirements.** (a) Gases capable of combining chemically. Cylinders, drums, tanks, tank motor vehicles, tank cars, and other containers must not contain gases capable of combining chemically. Compressed gases must be in metal cylinders unless otherwise specifically provided.

(b) **Odorization.** All liquefied petroleum gas in a tank motor vehicle shall be effectively odorized by an approved agent of such character as to indicate positively, by a distinctive odor, the presence of gas down to a concentration in air of not over one-fifth the lower limit of combustibility: Provided, however, That odorization is not required if harmful in the use of further processing of the liquefied petroleum gas, or if odorization will serve no useful purpose as a warning agent in such use or further processing.

NOTE 1: The lower limits of combustibility of the more commonly used liquefied petroleum gases are: Propane, 2.15 percent: Butane, 1.55 percent. These figures represent volumetric percentages of gas-air mixtures in each case.

NOTE 2: The use of 1.0 pound of ethyl mercaptan, 1.0 pound of thiophene or 1.4 pounds of amyl mercaptan per 10,000 gallons of liquefied petroleum gas shall be considered sufficient to meet the requirements of § 73.301 (b). (This note does not exclude the use of any other odorant in sufficient quantity to meet the requirements of § 73.301 (b).)

(c) Foreign cylinders. Except as authorized by §73.9, a charged container of foreign manufacture must not be offered for transportation in domestic traffic unless it has been made in accordance with the applicable ICC specification and unless the tests required by such specification were made in this country and proper report rendered.

(d) Ownership. Cylinders containing compressed gas must not be shipped unless they were charged by or with the consent of the owner of the cylinders.

(e) Retest. Cylinders for which prescribed periodic retests have become due must not be charged and shipped until such retests have been properly made.

(f) Manifolding containers in transportation. No means of interconnecting such as manifolding of individual containers may be employed for the transportation of compressed gases, except as hereinafter authorized. Containers so manifolded shall be supported and held together as a unit by structurally adequate means.

(1) Manifolding is authorized for containers of the following gases, provided, that each container is individually equipped with approved safety devices as required by § 73.34 (f) or § 73.315 (i); Air, Argon; Carbon Dioxide; Helium; Nitrogen; Nitrous Oxide; Oxygen.

(2) Manifolding is authorized for containers of the following gases, provided individual containers are equipped with approved safety devices as required by § 73.34 (f) or § 73.315 (i) and further provided that each container is equipped with individual shut-off valve, or valves, which shall be tightly closed while in transit. Manifold branch lines to these individual shut-off valves shall be sufficiently flexible to prevent injury to the valves which otherwise might result from the use of rigid branch lines. When a temperature measuring device is used on a cylinder the manifold shut-off valve shall be deemed the equivalent of the individual shut-off valve: boron trifluoride; ethylene (nonliquefied); hydrogen; hydrocarbon gases (nonliquefied); methane.

(3) Manifolding is authorized for containers of the following gases, provided individual containers are equipped with approved safety devices as required by § 73.34 (f) or § 73.315 (i), and further provided that each container is equipped with individual shut-off valve, or valves, which shall be tightly closed while in transit, and that each such container must be separately charged and means shall be provided to insure that no interchange of container contents can occur during transportation. Manifold branch lines to individual shut-off valves shall be sufficiently flexible to prevent injury to the valves which otherwise might result from the use of rigid branch lines: ethane; ethylene; propylene; liquefied petroleum gases; liquefied hydrocarbon gases.

(4) Manifolding is authorized for containers of acetylene, provided that each container is individually equipped with approved safety devices as required by § 73.34 (f) or § 73 315 (i), and further provided that each container is equipped with an individual shut-off valve, or valves, which shall be tightly closed while in transit. Manifold branch lines to these individual shut-off valves shall be sufficiently flexible to prevent injury to the valves which otherwise might result from the use of rigid branch lines. All manifolded containers shall be transported in a vertical position. For the checking of tare weights or for replacement of solvent the container shall be removed from the manifold. This subparagraph is not intended to prohibit the charging of the acetylene cylinders while manifolded.

(5) Manifolding is authorized for cargo tanks of the following gas provided individual cargo tanks are equipped with safety relief valves and gaging devices, as required by § 73.315 (h) and (i); and further provided, that each cargo tank is equipped with individual valves, or valves, which shall be tightly closed while in transit and that each such container must be separately charged: anhydrous ammonia.

(g) Service pressure. The service pressure for which a cylinder is designed is hereby defined as that which is marked on the cylinder. For example, for cylinders marked ICC-3A1800, the service pressure is 1,800 pounds per square inch gauge.

(1) For cylinders which are not marked to show service pressure, the authorized service pressures are as follows:

I. C. C. specification marking:	Authorized service pressure (pounds per square inch gauge)
ICC-3	1,800
ICC-3E	1,800
ICC-4	300
ICC-8	250
ICC-25	300
ICC-33	480
ICC-38	250
ICC-9	200
ICC-40	200

(2) For cylinders made prior to the effective date of specifications, the service pressure is hereby defined as being the same as for the same type of cylinder made in accordance with the current specifications.

(h) Weight and pressure check; verification of content. Except as noted in paragraph (h) (1) of this section, the amount of liquefied gas charged into cylinders or drums must be determined by weight and this weight must also be checked, after disconnecting from the charging line, by the use of proper scales. The pressure of nonliquefied gas and gas in solution must be checked daily on a representative cylinder after it has cooled to a settled temperature.

(1) Cylinders with a water capacity of 200 pounds or more and for use with a liquefied petroleum gas with a specific gravity at 60°F. of 0.504 or greater may have their contents determined by using a fixed length dip tube gauging device. The length of the dip tube shall be such that when a liquefied petroleum gas with a specific volume of 0.03051 cu. ft./lb. at a temperature of 40°F. is charged into the cylinder it just reaches the bottom of the tube. The weight of this liquid shall not exceed 42 percent of the water capacity of the cylinder, which must be stamped thereon. The length of the dip tube, expressed in inches carried out to one decimal place and prefixed with the letters DT, shall be stamped on the cylinder and on the exterior of removable type dip tube; for the purpose of this requirement the marked length shall be expressed as the distance measured along the axis of a straight tube from the top of the boss through which the tube is inserted to the proper level of the liquid in the cylinder. The length of each dip tube shall be checked when installed by weighing each cylinder after filling except when installed in groups of substantially identical cylinders in which case one of each 25 cylinders shall be weighed. The quantity of liquefied gas in each container must be checked by means of the dip tube after disconnecting the charging line. The outlet from the dip tube shall be not larger than a No. 54 drill size orifice. A container representative of each day's filling at each charging plant shall have its contents checked by weighing after disconnecting from the charging line.

(i) Valve protection. Cylinders containing flammable, corrosive, or noxious gases (hydrogen, pintsch gas, coal gas, chlorine, sulfur dioxide, etc.), must have their valves protected by metal caps securely attached to the cylinders and of sufficient strength to protect the valves from injury during transit: Provided, That these caps will not be required (1) if the cylinders are boxed or crated so as to give a proper protection to the valves; (2) if the valves are so recessed into the cylinders or otherwise protected so that they will not be subjected to a blow if the cylinder is dropped on a flat surface; (3) if, for cylinders containing nonliquefied gas under pressure not exceeding 300 pounds per square inch at 70°F., the valves are strong enough to avoid injury during transit; (4) if the cylinders are loaded in cars or motor vehicles by the consignor and to be unloaded by the consignee, are loaded compactly in an upright position, and are securely braced

§ 73.302 **Exemptions for compressed gases.** (a) Compressed gases, except poisonous gases as defined by § 73.326 (a), when in accordance with either subparagraphs (1), (2), (3), (4), (5), (6), (7), (8), or (9) of this paragraph, are exempt from specification packaging, marking, and labeling requirements, except that marking name of contents on outside container is required for shipments via carrier by water. Shipments for transportation by highway carriers are exempt also from Part 77, except § 77.817, and Part 197.

(1) In containers not exceeding 2-inches outside diameter and of not more than 4-fluid ounces capacity.

(2) Metal containers not over 1 quart capacity charged to not over 170 pounds per square inch at 70°F. or containers not over 30 gallons capacity charged to not over 75 pounds per square inch at 70°F., filled with nondangerous material to not over 90 percent capacity at 70°F. and then charged with nonflammable, nonliquefied gas. Each container must be tested before shipment to three times the gas pressure at 70°F., and when refilled and reshipped, must be retested at this pressure before each shipment.

(3) Inside nonrefillable metal containers charged with a solution of materials and compressed gas or gases, of capacity not exceeding 32 cubic inches. Contents of the container must be nonpoisonous and if flammable as provided in § 73.300 (b) (2), (3), and (4), the flash point, as determined by Bureau of Explosives' Method, must be not less than 20° Fahr. Pressure in the container must not exceed 75 pounds per square inch absolute at 70° Fahr. and the liquid content of the material and gas must not completely fill the container at 130° Fahr. However, if the pressure exceeds 55 pounds per square inch absolute at 70° Fahr., a spec. 2P container must be used. Each completed container filled for shipment must have been heated until content reached a minimum temperature of 130°Fahr. without evidence of leakage, distortion, or other defect.

(4) Carbonated beverages.

(5) Foodstuffs or soaps in metal cans with soluble or emulsified compressed gas, provided the pressure in the container does not exceed 115 pounds per square inch absolute at 70°F. or 150 pounds per square inch absolute at 130°F. The metal container must be capable of withstanding without bursting a pressure of two times the pressure of contents at 70°F. or one and one-half times the pressure of the contents at 130°F., whichever is greater.

(6) Cream in metal containers with soluble or emulsified compressed gas. Containers shall be of such design that they will hold pressure without permanent deformation up to 375 pounds per square inch gauge and shall be equipped with a device designed so as to release pressure without bursting of the container or dangerous projection of its parts at higher pressures. This exemption applies to shipments offered for transportation by refrigerated motor vehicle only.

(7) Inside nonrefillable metal containers charged with a solution containing biological products or a medical preparation which will be deteriorated by heat and compressed gas or gases, which is nonpoisonous and nonflammable, and of capacity not to exceed 31 83 cubic inches (17.6 fluid ounces). Pressure in the container not to exceed 55 pounds per square inch absolute at 70°F., and the liquid content of the product and gas must not completely fill the container at 130°F. One completed container out of each lot of 500 or less, filled for shipment, must have been heated until content reached a minimum temperature of 130°F., without evidence of leakage, distortion, or other defect.

(8) Electronic tubes of not more than 30 cubic-inch volume charged with gas to a pressure of not more than 35 pounds per square inch gauge.

(9) Inside nonrefillable metal containers of a capacity not to exceed 31.83 cubic inches (17.6 fluid ounces) charged with a solution of nonpoisonous and nonflammable materials and nonliquefied compressed gases. Pressure in the container not to exceed 105 pounds per square inch absolute at 70°F. or 140 pounds per square inch absolute at 130°F. The metal container must be capable of withstanding without bursting a pressure of two times the pressure of the contents at 70°F. or one and one-half times the pressure of the contents at 130°F., whichever is greater.

§ 73.303 **Truck bodies or trailers on flat cars; automobiles, motorcycles, tractors, or other self-propelled vehicles.** (a) Truck bodies or trailers with automatic heating or refrigerating equipment of the gas burning type may be shipped with fuel tanks filled and equipment operating or inoperative, when used for the transportation of other freight and loaded on flat cars as part of a joint rail-highway movement, provided the equipment and fuel supply are of a type approved by the Bureau of Explosives. The heating or refrigerating units are exempt from specification packaging, marking, and labeling requirements in this service and shall be considered as carriers equipment but not as shipments.

(b) Automobiles, motorcycles, tractors, or other self-propelled vehicles, equipped with liquefied petroleum gas or other fuel tanks, provided such tanks are securely closed, are exempt from specification packaging, marking, and labeling requirements, except that marking name of contents on outside container is required for shipments via carrier by water. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations. When offered for transportation by carriers by rail freight or highway, drainage of fuel tanks is not required. When offered for transportation by rail express, fuel tanks must have been emptied and securely closed.

§ 73.304 **Filling limits.** (a) The liquid portion, if any, of the gas must not completely fill the cylinder or drum at 130°F.

NOTE 1: Maximum filling densities are permitted by § 73.308 of this part for certain liquefied compressed gases having critical temperatures below 130°F. that result in the container being liquid full below the critical temperature, but because of compressibility of the liquids, the maximum pressure requirements of paragraph (e) of this section are met up to and including 130°F.

(b) For mixtures, the liquid portion of the gas plus any additional liquid or solid must not completely fill the container at 130°F.

(c) The pressure in the cylinder at 70°F. must not exceed the service pressure for which the container is designed (see § 73.301 (g) of this part), except as provided in paragraph (d) of this section.

(d) Spec. 3A and 3AA cylinders may be charged with compressed gases, other than liquefied, dissolved, poisonous, or flammable gases to a pressure 10 percent in excess of their marked service pressure, Provided:

(1) That such cylinders are equipped with frangible disc safety devices (without fusible metal backing) having a bursting pressure not exceeding the minimum prescribed test pressure.

(2) That the elastic expansion shall have been determined at the time of the last test or retest by the water jacket method.

(3) That either the average wall stress (see Note 1 of this sub-paragraph) or the maximum wall stress (see Note 2 of this subparagraph) shall not exceed the wall stress limitation shown in the following table:

Type of steel	Average wall stress limitation	Maximum wall stress limitation
Plain carbon steels over 0.35 carbon and medium manganese steels	53,000	58,000
Steels of analysis and heat-treatment specified in spec. 3AA	67,000	73,000
Plain carbon steels less than 0.35 carbon made prior to 1920	45,000	48,000

NOTE 1: The average wall stress shall be computed from the elastic expansion data using the following formula:

$$S = \frac{1.7EE}{KV} - 0.4P$$

where

S = wall stress, pounds per square inch
EE = elastic expansion (total less permanent) in cubic centimeters
K = factor x 10^{-7} experimentally determined for the particular type of cylinder being tested
V = internal volume in cubic centimeter (1 cubic inch = 16.387 cubic centimeters)
P = test pressure, pounds per square inch

Formula derived from formula of Note 2 and the following:

$$EE = PKV \times \frac{D^2}{D^2 - d^2}$$

NOTE 2: The maximum wall stress shall be computed from the formula:

$$S = P\frac{(1.3D^2 + 0.4d^2)}{D^2 - d^2}$$

where

S = wall stress, pounds per square inch
P = test pressure, pounds per square inch
D = outside diameter, inches
d = D − 2t, where t = minimum wall thickness determined by a suitable method

(4) That an external and internal visual examination made at the time of test or retest shows the cylinder to be free from excessive corrosion, pitting, or dangerous defects.

(5) That a plus sign (+) be added following the test date marking on the cylinder to indicate compliance with subparagraphs (d) (2), (3), and (4) of this section:

(e) The pressure in the cylinder at 130°F. must not exceed one and one-fourth times the service pressure for which the container is designed, except in the case of acetylene, nitrous oxide, and liquefied carbon dioxide (see § 73.301 (g) of this part).

NOTE 1: When a cylinder is charged in accordance with paragraph (d) of this section, the pressure in the cylinder at 130°F. must not exceed one and one-fourth times the filling pressure authorized therein.

(f) The pressure in ICC-4L cylinders must be limited by a pressure controlling valve so sized and set as to limit the pressure to one and one-fourth times the marked service pressure. The liquid portion of the gas must not completely fill the cylinder. For ICC-4L cylinders insulated by a vacuum the pressure control valve must be set at least 15 pounds per square inch lower than one and one-fourth times the marked service pressure The other paragraphs of this section do not apply to ICC-4L cylinders.

§ 73.305 **Compressed gas mixtures.** (a) Compressed gas and other material (mixtures of), offered for transportation, when not in violation of § 73.301 (a) and (b) of this part, must be shipped as required for compressed gas, except as follows:

(1) Mixtures containing any poisonous article, class C, in such proportion that the mixture would be classed as a poisonous article under § 73.381 (a) of this part, may be shipped in cylinders as authorized for such poisonous article.

(2) Mixtures containing any poisonous article, class A, in such proportion that the mixture would be classed as a poisonous article under § 73.326 (a) of this part, must be shipped in cylinders as authorized for such poisonous article.

§ 73.306 **Liquefied gases, except acetylene in solution.** (a) Liquefied gases, except acetylene in solution, for which charging requirements are not definitely prescribed in §§ 73.308 or 73.312, must be shipped subject to §§ 73.301 (a), (b), (c), (d), (e), (h), 73.303 (a), 73.304, 73.305, and 73.308 Note 12, in cylinders made under specification containers as follows:

(1) Spec. 3[1], 3A, 3AA, 3B, 3E, 4, 4A, 4B, 4BA, 4B-ET, 25[1], 26[1], or 38[1], also Spec. 9, 40, or 41, except that mixtures containing carbon bisulfide (disulfide), ethyl chloride, ethylene oxide, nickel carbonyl, spirits of nitroglycerin, zinc ethyl, or poisonous articles, class A, B, or C, as defined by this part are not permitted unless otherwise prescribed in this part. (See §§ 73.34 and 73.301 (g).)

(b) Mixtures containing compressed gas or gases including insecticides, which mixtures are nonpoisonous and nonflammable under this part must be shipped in cylinders as prescribed in paragraph (a) of this section, or as follows:

(1) Spec. 2P, inside metal containers equipped with safety devices of a type approved by the Bureau of Explosives and packed in strong wooden or fiber boxes of such design as to protect valves from injury or accidental functioning under conditions incident to transportation. Pressure in the container must not exceed 85 pounds per square inch absolute at 70°F. Each completed metal container filled for shipment must be heated until content reaches a minimum temperature of 130°F., without evidence of leakage, distortion or other defect. Each outside shipping container must be plainly marked "Inside containers comply with prescribed specifications."

(c) Refrigerant gases which are nonpoisonous and nonflammable under this part, must be shipped in cylinders as prescribed in § 73.308 of this part or subparagraph (a) (1) of this section, or as follows:

(1) Spec. 2P. Inside metal containers equipped with safety devices of a type approved by the Bureau of Explosives and packed in strong wooden or fiber boxes of such design as to protect valves from injury or accidental functioning under conditions incident to transportation. Pressure in the container must not exceed 85 pounds per square inch absolute at 70°F. Each completed metal container filled for shipment must be heated until content reaches a minimum temperature of 130°F., without evidence of leakage, distortion or other defect. Each outside shipping container must be plainly marked "Inside containers comply with prescribed specifications."

§ 73.307 Nonliquefied gases, except gas in solution or poisonous gas. (a) Nonliquefied gases, except gas in solution or poisonous gas, for which charging requirements are not definitely prescribed in § 73.308 of this part, must be shipped, subject to §§ 73.301 (a), (b), (c), (d), (e), (h), 73.303 (a), 73.304, 73.305, and 73.308 Note 12 of this part, in any type of cylinder made under specifications as follows:

(1) Spec. 3^1, 3A, 3AA, 3B, 3C, 3D, 3E, 4, 4A, 4B, 4BA, 4C, 7^1, 25^1, 26^1, 33^1, or 38^1. (See §§ 73.34 and 73 301 (g).

§ 73.308 Compressed gases in cylinders. (a) The following restrictions must be complied with for the gases named:

Kind of Gas	Maximum permitted filling density (See Note 12) (percent)	Cylinders (see Note 11) marked as shown in this column must be used except as provided in Note 1 and § 73.34 (a) to (e).
Anhydrous ammonia	54	ICC-4; ICC-3A480; ICC-3AA480; ICC-3A480X; ICC-4A480; ICC-4AA480; ICC-3.
Argon, pressurized liquid.	115	ICC-4L200.
Carbon dioxide, liquefied (see Notes 3 and 5)	68	ICC-3A1800; ICC-3AA1800; ICC-3.
Carbon dioxide—nitrous oxide mixtures	68	ICC-3A1800; ICC-3AA1800; ICC-3.
Carbon monoxide (see Note 13)		ICC-3A1800; ICC-3AA1800; ICC-3.
Chlorine (see Note 6)	125	ICC-3A480; ICC-3AA480; ICC-25; ICC-3; ICC-3BN480.
Cyclopropane	55	ICC-3A225; ICC-3A480X; ICC-3AA225; ICC-3B225; ICC-4A225; ICC-4AA480; ICC-4B225; ICC-4BA225; ICC-4B240ET; ICC-7-300; ICC-3; ICC-3E1800.
Dichlorodifluoromethane	119	ICC-3A225; ICC-3AA225; ICC-3B225; ICC-4A225; ICC-4B225; ICC-4BA225; ICC-4B240ET; ICC-9.
Dichlorodifluoromethane and difluoroethane mixture (constant boiling mixture)	(2)	ICC-3A240; ICC-3AA240; ICC-3B240 ICC-4A240; ICC-4B240; ICC-4BA240; ICC-9.
Difluoroethane	79	ICC-3A150; ICC-3AA150; ICC-3B150; ICC-4B150; ICC-4BA225.
Difluoromonochloroethane	100	ICC-3A150; ICC-3AA150, ICC-3B150; ICC-4B150; ICC-4BA225.
Dimethylamine, anhydrous	59	ICC-3A150; ICC-3AA150; ICC-3B150; ICC-4B150; ICC-4BA225.
Ethane	35.8	ICC-3A1800; ICC-3AA1800; ICC-3.
Ethane	36.8	ICC-3A2000; ICC-3AA2000.
Ethylene	31.0	ICC-3A1800; ICC-3AA1800; ICC-3.
Ethylene	32.5	ICC-3A2000; ICC-3AA2000.
Ethylene	35.5	ICC-3A2400; ICC-3AA2400.
Hydrogen chloride	60	ICC-3A1800; ICC-3AA1800; ICC-3.
Hydrogen sulfide	68	ICC-3A480; ICC-3AA480; ICC-3B480; ICC-4A480; ICC-4B480; ICC-4BA480; ICC-26-480.
Insecticide. liquefied gas (see Note 8)	(2)	ICC-3A300; ICC-3AA300; ICC-3B300; ICC-4B300; ICC-4BA300; ICC-9 ICC-40; ICC-41.
Liquefied nonflammable gases liquids other than those classified as flammable, corrosive, or poisonous and mixtures or solutions thereof, charged with nitrogen. carbon dioxide, or air (see Note 10)	(3)	ICC-3A300; ICC-3AA300; ICC-4B300; ICC-4BA300; ICC-4D300; ICC-4DA500.
Methyl chloride (see Note 4)	84	ICC-3A225; ICC-3AA225; ICC-3B225; ICC-4A225; ICC-4B225; ICC-4BA225; ICC-3; ICC-4; ICC-4B240ET; ICC-25; ICC-26-300; ICC-38.
Methyl mercaptan	80	ICC-3A240; ICC-3AA240; ICC-3B240; ICC-4B240; ICC-4BA240; ICC-4B-240ET.
Monochlorodifluoromethane	105	ICC-3A240; ICC-3AA240; ICC-3B240; ICC-4B240; ICC-4BA240; ICC-4B-240ET.
Monochloropentafluoroethane	110	ICC-3A225; ICC-3AA225; ICC-3B225; ICC-4A225; ICC-4B225; ICC-4BA225.
Monochlorotrifluoromethane	100	ICC-3A1800; ICC-3AA1800; ICC-3.
Monomethylamine, anhydrous	60	ICC-3A150; ICC-3AA150; ICC-3B150 ICC-4B150; ICC-4BA225.
Nitrogen, pressurized liquid	68	ICC-4L200.
Nitrosyl chloride	110	ICC-3BN400 only.
Nitrous oxide (see Note 2)	68	ICC-3A1800; ICC-3AA1800; ICC-3.
Oxygen, pressurized liquid	96	ICC-4L200.
Sulfur dioxide	125	ICC-3A225; ICC-3AA225; ICC-3B225; ICC-4A225; ICC-4B225; ICC-4BA225; ICC-3; ICC-4; ICC-4B240ET; ICC-25; ICC-26-150; ICC-38.
Sulfur hexafluoride	110	ICC-3A1800; ICC-3AA1800; ICC-3.
Tetrafluoroethylene, inhibited	90	ICC-3A1200; ICC-3AA1200; ICC-3E1800.
Trifluorochloroethylene	115	ICC-3A300; ICC-3AA300; ICC-3B300; ICC-4A300; ICC-4B300; ICC-4BA300.
Trimethylamine, anhydrous	57	ICC-3A150; ICC-3AA150; ICC-3B150; ICC-4B150; ICC-4BA225.
Vinyl chloride, inhibited (see Note 7)	84	ICC-4B150, without brazed seams; ICC-4BA225, without brazed seams; ICC-3A150; ICC-3AA150; ICC-25.
Vinyl methyl ether, inhibited (see Note 7)	68	ICC-4B150, without brazed seams; ICC-4BA225, without brazed seams; ICC-3A150; ICC-3AA150; ICC-3B150; ICC-25.

NOTE 1: Cylinders complying with spec. 3E are also authorized for all gases named in this table for which steel cylinders are authorized except where ICC-3A2000, 3AA2000, and 4L200 cylinders are specified.

NOTE 2: Filling density for nitrous oxide may be 75 percent incylinders made previous to February 1, 1917, of less than 12-pound water capacity, and if known to have passed a test pressure of not less than 3,500 pounds per square inch.

NOTE 3: The charge in carbon dioxide cylinders must not exceed 68 percent by weight of the water capacity of the cylinder. Cylinders rated for 75 pounds or for 100 pounds carbon dioxide capacity are the only cylinders authorized for shipment of more than 50 pounds of carbon dioxide except that cylinders of sizes not over 9 1/16 inches o. d. by 51 inches (approx.), charged with mixtures of carbon dioxide containing at least 6 percent by weight of other gas or liquid, are exempt from the foregoing part of this sentence.

NOTE 4: Cylinders ICC-3A150, ICC-3B150, ICC-4A150, and ICC-4B150 manufactured prior to December 7, 1936, are also authorized.

NOTE 5: Mining devices consisting of a cylinder containing carbon dioxide with a heating element, are authorized for shipment under the following conditions: Cylinders shall be of steel, have a calculated bursting pressure of at least 39,000 pounds per square inch, be fitted with a frangible disc that will operate at not over 57 percent of that pressure, be able to withstand a drop of 10 feet so as to strike crosswise on a steel rail while under internal pressure of at least 3,000 pounds per square inch, and be charged with not over 6 pounds of carbon dioxide gas at a filling density of not over 85 percent. (See Note 12 of this section); the cylinders are exempted from specification requirements other than the foregoing; the device must be shipped in strong boxes, described as liquefied carbon dioxide gas ("mining device"), and marked, labeled, and certified as prescribed for liquefied carbon dioxide.

NOTE 6: Cylinders purchased after October 1, 1944, for the transportation of chlorine must contain no aperture other than that provided in the neck of the cylinder for attachment of a valve equipped with an approved safety device. Cylinders purchased after November 1, 1935, and charged with chlorine must not contain over 150 pounds of gas.

NOTE 7: All parts of valve and safety devices in contact with contents of cylinders must be of a metal or other material, suitably treated if necessary, which will not cause formation of any acetylides.

NOTE 8: Cylinders of 86 cubic inches capacity or less must be packed in strong outside containers. (See § 73.25 of this part).

NOTE 10: Containers must be eqjuipped with approved safety devices and 4D spheres must be packed in strong boxes or crates. (See § 73.25 of this part).

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[1] Use of existing cylinders authorized, but new construction not authorized.

NOTE 11: Specs. 3[1], 25[1], 26[1], 33[1] and 38[1] are now obsolete but cylinders made thereunder may be continued in service.

NOTE 12: The "filling density" is hereby defined as the percent ratio of the weight of gas in a container to the weight of water that the container will hold.

NOTE 13: The pressure in the cylinder must not exceed 1000 pounds per square inch at 70°F.

[1] Use of existing cylinders authorized, but new construction not authorized.

[2] Section 73.304 (a) and (b).

[3] Section 73.304 (a) and (b) and the pressure in the container must not at 130°F exceed 5/4 the marked service pressure of the container.

§ 73.309 **Acetylene gas.** (a) Acetylene gas must be shipped in cylinders, spec. 8 or 8AL. The cylinders must be filled with a porous material that has been tested with satisfactory results by the Bureau of Explosives, and this material must be charged with a suitable solvent.

(1) The specific gravity of the solvent in acetylene cylinders must be 0.796 or over at 15.5°C., 59.9°F. The amount of solvent must not cause the tare weight of the cylinder to exceed its marked tare weight. The tare weight includes the weight of the cylinder proper, porous filling, valve, and solvent, but without removable cap.

(2) The amount of solvent at 70°F. for a cylinder having a shell water capacity exceeding 20 pounds (nominal) shall be determined from the following table:

Percent porosity of filler	Maximum acetone solvent percent shell capacity by volume
90 to 92	43.4
83 to 90	40.0
80 to 83	38.6
75 to 80	36.2
70 to 75	33.8
65 to 70	31.4

(3) The amount of solvent at 70°F. for a cylinder having a shell water capacity of 20 pounds or less (nominal) shall be determined from the following table:

Percent porosity of filler:	Maximum acetone solvent percent shell capacity by volume
90 to 92	41.8
83 to 90	38.5
80 to 83	37.1
75 to 80	34.8
70 to 75	32.5
65 to 70	30.2

NOTE 1: The amount of acetone specified in paragraph (a) (2) and (3) of this section must not be exceeded in the filling of cylinders manufactured prior to the effective date of this acetoning schedule.

(b) The pressure in cylinders containing acetylene gas must not exceed 250 pounds per square inch at 70°F., and in case the cylinders are marked for a lower allowable charging pressure at 70°F., then that pressure must not be exceeded.

(c) Cylinders containing acetylene gas must not be shipped unless they were charged by or with the consent of the owner, and by a person, firm, or company having possession of complete information as to the nature of the porous filling, the kind and quantity of solvent in the cylinders, and the meaning of such markings on the cylinders as are prescribed by the Commission's regulations and specifications applying to containers for the transportation of acetylene gas.

§ 73.310 **Fire extinguishers and component parts thereof.** (a) Fire extinguishers and component parts thereof containing compressed gas for the purpose of expelling fire extinguishing contents, which must be nonliquefied gas when in containers exceeding 30 cubic inches capacity, when shipped under the following conditions are exempt from specification packaging, marking, and labeling requirements, except that marking name of contents on outside container is required for shipments via carrier by water Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817, and Part 197.

(1) Must be shipped as inside containers.

(2) The container under stored pressure shall have an internal volume not exceeding 1.100 cubic inches.

(3) The pressure in the container shall not exceed 200 pounds per square inch at 70°F.

(4) The contents shall be nonflammable as covered in §§ 73.115 and 73.150 of this part; nonpoisonous as covered in § 73.325 (a), class A, B, or C of this part; and not corrosive as defined in § 73.240 of this part.

(5) Except as provided in subparagraph (a) (6) of this section, each container must be tested before shipment to at least three times the pressure in the container at 70°F. when charged and not less than 120 pounds per square inch, and before refilling and reshipping must be retested at this pressure before each shipment. The container shall show no leakage or damage when subjected to this pressure.

(6) When spec. 2P metal cans are used as inside containers for pressures not exceeding 85 pounds per square inch, absolute, at 70°F. or 115 pounds per square inch, absolute, at 130°F. the test requirements of subparagraph (a) (5) of this section do not apply, but each container must be capable of having the contents heated to 130°F. without evidence of leakage or permanent distortion.

§ 73.311 **Fluorine.** (a) Flourine must be shipped in metal cylinders complying with Spec. 3A1000, 3AA1000, or 3BN400, equipped with valve protection caps and subject to § 73.34 (f) (4); cylinders must not be charged to over 400 pounds per square inch gauge, at 70°F.; cylinders must not contain over 6 pounds of gas.

§ 73.312 **Liquefied petroleum gas.** (a) Liquefied petroleum gas must be charged into specification containers as follows:

(1) Spec. 3[1], 3A, 3AA, 3B, 3E, 4, 4A, 4B, 4BA, 4B240X[1] (see appendix A to Subpart C of Part 78), 4B240FLW, 4B240ET or 9, 25[1], 26[1], 38[1], or 41. Cylinders authorized under § 73.34 (a) to (e) may be used.

NOTE 1: Because of the present emergency and until further order of the Commission, cylinders marked as complying with I C.C. Spec. 4B240FLW bearing manufacturer's symbol WCO and serial numbers 47A-1 to 47 A-59200, inclusive, varying from the specification requirements as to physical properties of steel, are authorized for the transportation of liquefied petroleum gases.

(2) Spec. 3C or 4C. Cylinders are authorized when capacity of cylinders does not exceed 3,881 cu. in. (16 gallons with 5 percent tolerance), for liquefied petroleum gas with gas pressure not over 145 pounds per square inch, gauge, at 130°F.

(3) Spec. 7[1]. Cylinders when made prior to October 1, 1930, are authorized when capacity of cylinder does not exceed 3,881 cu in. (16 gallons with 5 percent tolerance), for liquefied petroleum gas with gas pressure not over 70 pounds per square inch at 70°F., nor over 145 pounds per square inch at 130°F.

(4) Spec. 7[1]. Cylinders made prior to October 1, 1930, and lawfully marked ICC-7-150, are authorized for the shipment of liquefied petroleum gas, subject to § 73.304 of this part, provided they have been satisfactorily retested, by water jacketed test, as prescribed in § 73.31 (j) and (k) of this part.

(5) Spec. 5. Metal drums made prior to October 1, 1930, of 11 gallons capacity and made of steel at least 16 gauge United States standard, are authorized for gas pressure not over 23 pounds per square inch at 70°F., nor over 70 pounds per square inch at 130°F.

(6) Spec. 5F. Metal drums. Authorized for gas pressure not over 28 pounds per square inch at 70°F., nor over 86 pounds per square inch at 130°F.

(7) Spec. 2P. Inside metal containers packed in strong wooden or fiber boxes of such design as to protect valves from injury or accidental functioning under conditions incident to transportation. Authorized for liquefied petroleum gas with a gas pressure not over 45 pounds per square inch gauge at 70°F., and 105 pounds per square inch gauge at 130°F. Containers must be equipped with safety devices which will prevent rupture of the containers and dangerous projection of the closing devices when the containers are exposed to the action of fire. Each completed container filled for shipment must have been heated until contents reached a minimum temperature of 130°F., without evidence of leakage, distortion, or other defect. Each outside shipping container must be plainly marked "Inside containers comply with prescribed specifications."

(b) Filling density limited as follows:

Minimum specific gravity of the liquid material at 60° F.	Maximum filling density in percent of the water-weight capacity of the container	Minimum specific gravity of the liquid material at 60° F.	Maximum filling density in percent of the water weight capacity of the container
0.271-0.289	26	0.504-0.510	42
0.290-0.306	27	0.511-0.519	43
0.307-0.322	28	0.520-0.527	44
0.323-0.338	29	0.528-0.536	45
0.339-0.354	30	0.537-0.544	46
0.355-0.371	31	0.545-0.552	47
0.372-0.398	32	0.553-0.560	48
0.399-0.425	33	0.561-0.568	49
0.426-0.440	34	0.569-0.576	50
0.441-0.452	35	0.577-0.584	51
0.453-0.462	36	0.585-0.592	52
0.463-0.472	37	0.593-0.600	53
0.473-0.480	38	0.601-0.608	54
0.481-0.488	39	0.609-0.617	55
0.489-0.495	40	0.618-0.626	56
0.496-0.503	41	0.627-0.634	57

(c) Subject to § 73.304 (c), any filling density percentage prescribed in this section is authorized to be increased by 2 for liquefied petroleum gas in spec. 26[1] or 3[1] cylinders or in spec. 3A marked for 1,800 pounds, or higher, service pressure.

§ 73.313 **Refrigerating machines and hydraulic accumulators.** (a) Refrigerating machines of the self-contained type containing not over 50 pounds of gas in each pressure vessel and containing not more than two charged pressure vessels, refrigerating machines of the remote-control type consisting of separate units shipped separately and each containing not over 25 pounds weight of gas, or other similar apparatus assembled for shipment containing not over 15 pounds weight of gas or liquid for their operation, when shipped under the following conditions are exempt from specification packaging, marking, and labeling requirements, except that marking name of contents on outside container is required for shipments via carrier by water. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

(1) All parts subject to gas pressure during shipment must be tested during manufacture by interior pressure and must show no leakage or indication of failure under the test; for liquefied gas the test pressure must be 4 times and for nonliquefied gas it must be 5/3 times the gas pressure at 70°F.

(2) The liquid portion of the gas, if any, must not completely fill the container at 130°F.

(3) The amount of gas, if liquefied, must not exceed the filling densities prescribed in §§ 73.308 or 73.312 of this part.

(4) Any unit of a refrigerating machine of the self-contained type containing more than one pressure vessel charged with 50 pounds of gas as authorized in this section shall have each such pressure vessel equipped with a safety device meeting the requirements or the American Standard Safety Code for Mechanical Refrigeration (ASA-B9) and individual shut-off valve or valves which shall be closed while in transportation. Such pressure vessels shall be manufactured and inspected in accordance with Section VIII of the American Society of Mechanical Engineers Code, 1949 or 1950 Edition.

(b) Hydraulic accumulators and component parts thereof containing nonliquefied gas for the purpose of operation when shipped under the following conditions are exempt from specification packaging, marking, and labeling requirements, except that marking name of contents on outside container is required for shipments via carrier by water. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

(1) Must be shipped as inside containers.

(2) The container under stored pressure shall have an internal volume not exceeding 1,100 cubic inches.

(3) The pressure in the container shall not exceed 200 pounds per square inch at 70°F.

(4) The contents shall be nonflammable as covered in § 73.115.

(5) Each container must be tested before shipment to at least three times the pressure in the container at 70°F. when charged and not less than 120 pounds per square inch, and before refilling and reshipping must be retested at this pressure before each shipment. The container shall show no leakage or damage when subjected to this pressure.

§ 73.314 **Compressed gases in tank cars.** (a) Compressed gases must not be shipped in tank cars except as provided in paragraphs (b) to (f) of this section, § 73.432, and in the following table:

Kind of Gas	Maximum permitted filling density, Note 1	Required type of tank car, Note 2
	Percent	
Anhydrous ammonia	50	ICC-106A500, 106A500X, Note 12.
	57	ICC-105A300-W.
Argon	Note 5	ICC-107A.
Butadiene (pressure not exceeding 75 pounds per square inch at 105° F.), inhibited	Notes 3 and 6	ICC-106A500, 106A500X. ICC-105A100, 105A100-W, Note 9.
Carbon dioxide, liquefied	Note 10	ICC-105A500-W, 105A600-W, Note 11.
Chlorine	125	ICC-106A500, 106A500X, Note 12.
	125	ICC-105A300-W, Notes 8 and 18.
Crude nitrogen fertilizer solution	Note 6	ICC-106A500, 106A500X. ICC-105A100AL-W, 105A300-W, 109A100AL-W, Note 5.
Dichlorodifluoromethane	119	ICC-106A500, 106A500X, 110A500-W, Notes 12 and 19.
	125	ICC-105A300-W.
Dichlorodifluoromethane and difluoroethane mixture (constant boiling mixture)	Note 6	ICC-106A500, 106A500X, Note 12. ICC-110A500-W. ICC-105A300-W.
Dichlorodifluoromethane-dichlorotetrafluoroethane mixture	119	ICC-106A500, 106A500X, 110A500-W, Notes 12 and 19.
	125	ICC-105A300-W.
Dichlorofluoromethane-monochlorodifluoromethane mixture	119	ICC-106A500, 106A500X, 110A500-W, Notes 12 and 19.
	125	ICC-105A300-W.
Dichlorodifluoromethane-monofluorotrichloromethane mixture	Note 16	ICC-106A500, 106A500X, 110A500-W, Note 12. ICC-105A300-W.
Dichlorodifluoromethane-trichloromonofluoromethane-monochlorodifluoromethane mixture	119	ICC-106A500, 106A500X, 110A500-W, Notes 12 and 19.
	125	ICC-105A300-W.
Dichlorodifluoromethane-trichlorotrifluoroethane mixture	119	ICC-106A500, 106A500X, 110A500-W, Notes 12 and 19.
	125	ICC-105A300-W.
Difluoroethane	79	ICC-106A500, 106A500X, 110A500-W, Note 12.
Difluoromonochloroethane	100	ICC-106A500, 106A500X, 110A500-W, Note 12.
Dimethylamine, anhydrous	59	ICC-106A500, 106A500X.
	62	ICC-105A300-W, Note 9.
Dimethyl ether	59	ICC-106A500, 106A500X.
	62	ICC-105A300-W, Note 9.

Kind of Gas	Maximum permitted filling density, Note 1	Required type of tank car, Note 2
	Percent	
Dispersant gas, n.o.s.	Note 16	ICC-106A500, 106A500X, Notes 12 and 19. ICC-110A500-W, Note 19. ICC-105A300-W, Note 19.
Fertiliser ammoniating solution containing free ammonia	Note 6	ICC-106A500, 106A500X. ICC-105A100AL-W, 105A300-W, 109A100AL-W, Note 5.
Helium	Note 5	ICC-107A.
Hydrogen	Note 5	ICC-107A, Note 7.
Hydrogen sulfide	68	ICC-106A800, 106A800X, Notes 12 and 13.
Liquid hydrocarbon gas (pressure not exceeding 75 pounds per square inch at 105° F.)	Note 6	ICC-105A100, 105A100-W, Note 9.
Liquid hydrocarbon gas (pressure not exceeding 225 pounds per square inch at 105° F.)	Note 6	ICC-105A300-W, Note 9.
Liquid hydrocarbon gas (pressure not exceeding 300 pounds per square inch at 105° F.)	Note 6	ICC-105A400-W, Note 9.
Liquid hydrocarbon gas (pressure not exceeding 375 pounds per square inch at 105° F.)	Note 6	ICC-105A500-W, Note 9.
Liquid hydrocarbon gas (pressure not exceeding 375 pounds per square inch at 130° F.)	Note 6	ICC-106A500, 106A500X.
Liquid hydrocarbon gas (pressure not exceeding 450 pounds per square inch at 105° F.)	Note 6	ICC-105A600-W, Note 9.
Liquefied petroleum gas (pressure not exceeding 75 pounds per square inch at 105° F.)	Note 3	ICC-105A100, 105A100-W, Note 9.
Liquefied petroleum gas (pressure not exceeding 225 pounds per square inch at 105° F.)	Note 3	ICC-105A300-W, Notes 5 and 9.
Liquefied petroleum gas (pressure not exceeding 300 pounds per square inch at 105° F.)	Note 3	ICC-105A400-W, Notes 5 and 9.
Liquefied petroleum gas (pressure not exceeding 375 pounds per square inch at 105° F.)	Note 3	ICC-105A500-W, Notes 5 and 9.
Liquefied petroleum gas (pressure not exceeding 375 pounds per square inch at 130° F.)	Note 4	ICC-106A500, 106A500X.
Liquefied petroleum gas (pressure not exceeding 450 pounds per square inch at 105° F.)	Note 3	ICC-105A600-W, Notes 5 and 9.
Methyl chloride	84	ICC-106A500, 106A500X, Note 12. ICC-105A300-W, Note 9.
Methyl mercaptan	80	ICC-106A500, 106A500X, Notes 12 and 20.
	82	ICC-105A300-W, Note 9.
Monochlorodifluoromethane	105	ICC-106A500, 106A500X, 110A500-W, Note 12.
	110	ICC-105A300-W.
Monochlorotetrafluoroethane	125	ICC-106A500, 106A500X, 110A500-W, Note 12.
Monomethylamine, anhydrous	60	ICC-106A500, 106A500X.
	62	ICC-105A300-W, Note 9.
Nitrogen	Note 5	ICC-107A.
Nitrogen fertilizer solution	Note 6	ICC-106A500, 106A500X. ICC-105A100AL-W, 105A300-W, 109A100AL-W, Note 5.
Nitrogen fertilizer solution (pressure not exceeding 75 pounds per square inch at 105° F.)	Note 6	ICC-105A100AL-W.
Nitrosyl chloride	110	ICC-106A800NCI, Notes 12 and 17
	124	ICC-105A300-W, Note 15.
Oxygen	Note 5	ICC-107A.
Refrigerant gas, n.o.s.	Note 16	ICC-106A500, 106A500X, Notes 12 and 19. ICC-110A500-W, Note 19. ICC-105A300-W, Note 19.
Sulfur dioxide	125	ICC-106A500, 106A500X, 110A500-W, Note 12. ICC-105A300-W.
Trifluorochloroethylene	115	ICC-106A500, 106A500X, Note 12.
	115	ICC-110A500-W.
	120	ICC-105A300-W, Note 9.
Trimethylamine, anhydrous	57	ICC-106A500, 106A500X.
	59	ICC-105A300-W, Note 9.
Vinyl chloride, inhibited (see Note 14)	84	ICC-106A500, 106A500X, Note 12.
	87	ICC-105A300-W, Note 9.
Vinyl methyl ether, inhibited (see Note 14)	68	ICC-105A100, 105A100-W, 105A300-W Note 9.

NOTE 1: The filling density for liquefied gases is hereby defined as the percent ratio of the weight of gas in the tank to the weight of water that the tank will hold. For determining the water capacity of the tank in pounds, the weight of a gallon (231 cubic inches) of water at 60°F. in air shall be 8.32828 pounds.

NOTE 2: When tank cars marked ICC-105A300-W are prescribed, tank cars marked ICC-105A400-W, 105A500-W, and 105A600-W may also be used. When ICC-105A100 or ICC-105A100-W tank cars are prescribed, tank cars marked ICC-105A300-W, 105A400-W, 105A500-W, and 105A600-W, may also be used. When tank cars marked ICC-105A100AL-W are prescribed, tank cars marked ICC-105A300AL-W may also be used. When ICC-106A500 and 106A500X tank cars are prescribed, tank cars marked ICC-106A800 and 106A800X may also be used.

NOTE 3: (a) Maximum permitted filling density in tank cars transporting liquefied petroleum gas or butadiene of specific gravity shown, taken at 60 degrees Fahrenheit.

Specific gravity	Filling density	Specific gravity	Filling density	Specific gravity	Filling density	Specific gravity	Filling density
0.500	45.500	0.534	49.750	0.568	53.600	0.602	57.080
0.501	45.600	0.535	49.875	0.569	53.700	0.603	57.170
0.502	45.700	0.536	50.000	0.570	53.800	0.604	57.260
0.503	45.800	0.537	50.100	0.571	53.900	0.605	57.350
0.504	45.900	0.538	50.200	0.572	54.000	0.606	57.440
0.505	46.000	0.539	50.300	0.573	54.125	0.607	57.530
0.506	46.125	0.540	50.400	0.574	54.250	0.608	57.620
0.507	46.250	0.541	50.500	0.575	54.375	0.609	57.710
0.508	46.375	0.542	50.625	0.576	54.500	0.610	57.800
0.509	46.500	0.543	50.750	0.577	54.600	0.611	57.890
0.510	46.750	0.544	50.875	0.578	54.700	0.612	57.980
0.511	47.000	0.545	51.000	0.579	54.800	0.613	58.070
0.512	47.125	0.546	51.100	0.580	54.900	0.614	58.160
0.513	47.250	0.547	51.200	0.581	55.000	0.615	58.250
0.514	47.375	0.548	51.300	0.582	55.100	0.616	58.340
0.515	47.500	0.549	51.400	0.583	55.200	0.617	58.430
0.516	47.625	0.550	51.500	0.584	55.300	0.618	58.520
0.517	47.750	0.551	51.625	0.585	55.400	0.619	58.610
0.518	47.875	0.552	51.750	0.586	55.500	0.620	58.700
0.519	48.000	0.553	51.875	0.587	55.625	0.621	58.790
0.520	48.125	0.554	52.000	0.588	55.750	0.622	58.880
0.521	48.250	0.555	52.125	0.589	55.875	0.623	58.970
0.522	48.375	0.556	52.250	0.590	56.000	0.624	59.060
0.523	48.500	0.557	52.375	0.591	56.090	0.625	59.150
0.524	48.600	0.558	52.500	0.592	56.180	0.626	59.240
0.525	48.700	0.559	52.625	0.593	56.270	0.627	59.330
0.526	48.800	0.560	52.750	0.594	56.360	0.628	59.420
0.527	48.900	0.561	52.875	0.595	56.450	0.629	59.510
0.528	49.000	0.562	53.000	0.596	56.540	0.630	59.600
0.529	49.125	0.563	53.100	0.597	56.630	0.631	59.690
0.530	49.250	0.564	53.200	0.598	56.720	0.632	59.780
0.531	49.375	0.565	53.300	0.599	56.810	0.633	59.870
0.532	49.500	0.566	53.400	0.600	56.900	0.634	59.960
0.533	49.625	0.567	53.500	0.601	56.990	0.635	60.050

NOTE 3: (b) Because of the present emergency and until further order of the Commission, and only for shipments made during the months of November to March, inclusive, the following filling densities may be used in lieu of these specified in the table in Note 3 (a):

Specific gravity	Filling density	Specific gravity	Filling density	Specific gravity	Filling density	Specific gravity	Filling density
0.500	47.40	0.534	51.12	0.568	54.75	0.602	58.20
0.501	47.51	0.535	51.23	0.569	54.85	0.603	58.29
0.502	47.62	0.536	51.34	0.570	54.96	0.604	58.39
0.503	47.73	0.537	51.45	0.571	55.06	0.605	58.49
0.504	47.84	0.538	51.56	0.572	55.17	0.606	58.58
0.505	47.95	0.539	51.67	0.573	55.27	0.607	58.68
0.506	48.06	0.540	51.78	0.574	55.38	0.608	58.77
0.507	48.17	0.541	51.88	0.575	55.48	0.609	58.87
0.508	48.28	0.542	51.99	0.576	55.59	0.610	58.97
0.509	48.39	0.543	52.09	0.577	55.69	0.611	59.06
0.510	48.51	0.544	52.20	0.578	55.80	0.612	59.16
0.511	48.61	0.545	52.31	0.579	55.90	0.613	59.26
0.512	48.72	0.546	52.41	0.580	56.01	0.614	59.35
0.513	48.83	0.547	52.52	0.581	56.11	0.615	59.45
0.514	48.94	0.548	52.62	0.582	56.22	0.616	59.55
0.515	49.05	0.549	52.73	0.583	56.32	0.617	59.64
0.516	49.16	0.550	52.84	0.584	56.43	0.618	59.74
0.517	49.27	0.551	52.94	0.585	56.53	0.619	59.84
0.518	49.38	0.552	53.05	0.586	56.64	0.620	59.94
0.519	49.49	0.553	53.16	0.587	56.74	0.621	60.03
0.520	49.60	0.554	53.26	0.588	56.85	0.622	60.13
0.521	49.70	0.555	53.37	0.589	56.95	0.623	60.23
0.522	49.81	0.556	53.48	0.590	57.06	0.024	60.32
0.523	49.92	0.557	53.58	0.591	57.15	0.625	60.42
0.524	50.03	0.558	53.69	0.592	57.25	0.626	60.52
0.525	50.14	0.559	53.80	0.593	57.34	0.627	60.61
0.526	50.25	0.560	53.91	0.594	57.44	0.628	60.71
0.527	50.36	0.561	54.01	0.595	57.53	0.629	60.81
0.528	50.47	0.562	54.12	0.596	57.63	0.630	60.91
0.529	50.58	0.563	54.22	0.597	57.72	0.631	61.00
0.530	50.69	0.564	54.33	0.598	57.82	0.632	61.09
0.531	50.79	0.565	54.43	0.599	57.91	0.633	61.19
0.532	50.90	0.566	54.54	0.600	58.01	0.634	61.19
0.533	51.01	0.567	54.64	0.601	58.10	0.635	61.23

NOTE 4: See § 73.312 (b) of this part.

NOTE 5: See § 73.314 (b) of this part.

NOTE 6: See § 73.314 (c) of this part.

NOTE 7: Before any ICC-107A tank car may be used for shipments of hydrogen the following requirements must be complied with. Each tank must be equipped with one or more safety devices of approved type and discharge area, the discharge outlet of each safety device must be connected to a manifold having an unobstructed discharge area of at least one and one-half times the total discharge area of the safety devices connceted to the manifold; all manifolds must be connected to a single common header having an unobstructed discharge outlet pointing upward and extending above top of the car; the header and the header outlet must each have an unobstructed discharge area at least equal to the total discharge area of the manifolds connected to the header; the header outlet must be equipped with an approved ignition device which will instantly ignite any hydrogen discharged through the safety devices.

NOTE 8: For tank cars of other than ICC-106A type, used for shipping chlorine, tests prescribed in § 73.31 must be made at intervals of 2 years or less and interior pipes of liquid discharge valves must be equipped with check valves of approved design.

NOTE 9: For tank cars other than 106A type, used for the transportation of liquefied flammable gases, interior pipes of loading and unloading valves must be equipped with excess flow valves of approved design.

NOTE 10: The liquid portion of the gas at 0°F. must not completely fill the tank.

NOTE 11: Before an ICC-105A500W or ICC-105A-600W tank car may be used for the transportation of liquefied carbon dioxide, the following requirements must be met: Tank must be lagged with an approved insulation material of a thickness so that the thermal conductance is not more than 0.03 B.t.u. per square foot per degree F. differential in temperature per hour; except that the insulation thickness directly over the center sills may be reduced to give a thermal conductance not exceeding 0.04 B.t.u. per square foot, per degree F. differential in temperature per hour; this reduction is to permit an anchorage which must not exceed seven (7) inches from top of center sills to bottom of tank. Tank must be equipped with one safety valve of approved design set to open at a pressure not exceeding three-fourths of the test pressure of the tank and one frangible disc device of approved design set to function at a pressure less than the test pressure of the tank. The discharge capacity of each of these safety devices must be sufficient to prevent building up of pressure in tank in excess of three-fourths of the test pressure of the tank. Tank must be equipped with two (2) pressure-regulating valves of approved design, set to open at a pressure not to exceed 350 pounds per square inch or seven-tenths of the test pressure of the tank. Each regulating valve and safety device must have its final discharge piped to the outside of the protective housing.

NOTE 12: Tanks complying with specification 106A-500 or 106A500X containing chlorine, anhydrous ammonia, sulfur dioxide, methyl chloride, methyl mercaptan, dichlorodifluoromethane, monochlorodifluoroethane, monochlortetrafluoroethane, vinyl chloride, inhibited, difluoroethane, difluoromonochloroethane, dispersant gas, n.o.s., refrigerant gas, n.o.s., dichlorodifluoromethane and difluoroethane mixture (constant boiling mixture), dichlorodifluoromethane-monofluorotrichloromethane mixture, trifluorochloroethylene, dichlorodifluoromethane-dichlorotetrafluoroethane mixture, dichlorodifluoromethane-trichlorotrifluoroethane mixture, dichlorodifluoromethane-monochlorodifluoromethane mixture, or dichlorodifluoromethane-trichloromonofluoromethane - monochlorodifluoromethane mixture; tanks complying with specification 110A500W, containing dichlorodifluoromethane, monochlorodifluoromethane, dichlorodifluoromethane-monofluorotrichloromethane mixture, dichlorodifluoromethane-dichlorotetrafluoroethane mixture, dichlorodifluoromethane-trichlorotrifluoroethane mixture, dichlorodifluoromethane-monochlorodifluoromethane mixture, dichlorodifluoromethane-trichloromonofluoromethane - monochlorodifluoromethane mixture, dispersant gas, n.o s., or refrigerant gas, n.o.s.; tanks complying with specification 106A800 or 106A800X, containing hydrogen sulfide; or tanks complying with specification 106A800NC, containing nitrosyl chloride, may be transported on trucks or semi-trailers only, when securely chocked or clamped thereon to prevent shifting, and provided adequate facilities are present for handling tanks where transfer in transit is necessary. See § 74.560, for rail freight-motor vehicle shipments.

NOTE 13: Container shall not be equipped with safety devices of any description and valves must be protected by supplemental gastight closures approved by the Bureau of Explosives.

NOTE 14: All parts of valves and safety devices in contact with contents of tank must be of a metal or other material suitably treated if necessary, which will not cause formation of any acetylides.

NOTE 15: Before an ICC-105A300-W tank car may be used for the transportation of nitrosyl chloride, the following requirements must be met: Tanks must be made of or clad with a metal not subject to rapid deterioration by the lading; all appurtenances, such as manhole covers, venting, loading and discharge valves, safety valves, check valves, and eduction pipes, must be made of metal not subject to rapid deterioration by the lading; cork must be used as an insulating material.

NOTE 16: See paragraphs (b) and (c) of this section.

NOTE 17: Safety vents must be of the fusible plug type and must function at a temperature of not exceeding 175° F. and be vapor tight at 130°F.

NOTE 18: The maximum quantity of liquefied chlorine gas loaded into tanks mounted on one car structure must not exceed 60,000 pounds. Provided, That for single-unit tank car tanks having water weight capacities not less than 86,240 pounds not over 90,640 pounds, lagged with 4 inches of corkboard, equipped with one or more safety valves set to open at a pressure of 225 pounds per square inch, the total discharge capacity of which must be sufficient to prevent building up of pressure in the tank in excess of 225 pounds per square inch, tank jackets stenciled ICC-105A300W and in all other respects constructed and maintained in full compliance with I.C.C. shipping container specification 105A500W, the quantity of gas loaded into such tanks must be not more than 110,000 pounds nor less than 107,800 pounds.

NOTE 19: Only dichlorodifluoromethane, dichlorodifluoromethane-difluoroethane mixture (constant boiling mixture), dichlorodifluoromethane - monofluorotrichloromethane mixture, dichlorodifluoromethane-dichlorotetrafluoroethane mixture, dichlorodifluoromethane-tricholorotrifluoroethane mixture, dichlorodifluoromethane-monochlorodifluoromethane mixture, dicholorodifluoromethane-trichloromonofluoromethane - monochlorodifluoromethane mixture, difluoroethane, difluoromonochloroethane, monochlorodifluoromethane, and monochlorotetrafluoroethane may be shipped as dispersant gas, n.o.s. or refrigerant gas, n.o.s. in accordance with provisions of table (a).

NOTE 20: Container shall not be equipped with safety devices of any description.

(b) The gas pressure at 105°F. in any lagged tank of tank cars of specs. 105A100, 105A100-W, 105A100AL-W, 105A300AL-W, 105A300-W, 105A400-W, 105A500-W, 105A600-W, 109A100AL-W, and at 130°F. in any unlagged tank of tank cars of specs. 106A500, 106A500X, 106A800, 106A800X, and 110A500-W must not exceed three-fourth times the prescribed retest pressure of the tank. The gas pressure at 130°F. in any unlagged tank of tank cars of the 107A series must not exceed seven-tenths of the marked test pressure of the tank.

NOTE 1: Because of the present emergency and until further order of the Commission, ICC-107A tanks may be charged with helium to a pressure 10 percent in excess of the marked maximum gas pressure at 130°F. of each tank.

(c) The liquid portion of the gas at 105°F. must not completely fill a lagged tank nor at 130°F. completely fill an unlagged tank.

(d) The amount of liquefied gas charged into each tank may be determined either, first, by weight, and this weight must be checked after disconnecting the charging line, by the use of proper scales, or second, the weight of liquefied petroleum gas, dimethylamine, monomethylamine, and trimethylamine may be calculated using the outage tables supplied by the tank car owners and the specific gravities as determined at the plant, and this computation must be checked by determination of specific gravity of product after loading. Carriers may verify calculated weights by use of proper scales.

(e) Tank cars containing compressed gases must not be shipped unless they were loaded by or with the consent of the owner thereof; and must not be loaded with any gas which combines chemically with the gas previously loaded therein, until all residue has been removed and interior of tank thoroughly cleaned. For cars of the ICC-106A and 110A500W type, the tanks must be placed in position and attached to car structure by the shipper.

(f) Except as authorized by § 73.8, tank cars made in foreign countries, except Canada, must not be used in domestic traffic until they have been tested in this country and proper reports rendered as required by the specifications that apply.

§ 73.315 Compressed gases in cargo tanks and portable tank containers. (a) Cargo tanks and portable tank containers must not contain gases capable of combining chemically.

(1) Compressed gases must not be shipped in cargo tanks or portable tank containers except as provided in this section and §§ 73.32 and 73.33 of this part, and in the following table (for marking requirements see §§73.401 (a) (1) and 77.823 (d)).

Kind of gas	Maximum Permitted Filling Density		Specification Container Required	
	Percent by weight (See Note 1)	Percent by volume (See par. (f) of this section)	Type (See Note 2)	Minimum design working pressure (psig)
Anhydrous ammonia..	56	82 See Note 5	ICC-51, MC-330	265
Anhydrous dimethylamine	59	See Note 7	ICC-51, MC-330	150
Anhydrous monomethylamine	60	See Note 7	ICC-51, MC-330	150
Anhydrous trimethylamine	57	See Note 7	ICC-51, MC-330	150
Carbon dioxide, liquefied...............	See par. (c) of this section	95	ICC-51, MC-330	200; see Note 3
Chlorine.............	125	See Note 7	MC-330	225; see Notes 4 and 8
Dichlorodifluoromethane...........	119	See Note 7, ICC-51	MC-330	150
Dichlorodifluoromethane-dichlorotetrafluoroethane mixture............	119	See Note 7	ICC-51, MC-300	150
Dichlorodifluoromethane-monofluorotrichloromethane mixture...	See par. (c) of this section	See Note 7, ICC-51	MC-330	150
Liquefied petroleum gas	See par. (b) of this section	See par. (b) of this section.	ICC-51, MC-330	See subpar. (b) (1) of this section
Methyl chloride......	84	88.5	ICC-51, MC-330	150
Methyl chloride (optional portable tank 2,000 pounds water capacity, fusible plug)	84	See Note 6	ICC-51	225
Monochlorodifluoromethane...........	105	See Note 7	ICC-51, MC-330	250
Nitrous oxide.........	See par. (c) of this section	95	ICC-51, MC-330	200; see Note 3
Sulfur dioxide (tanks not over 1,200 gallons water capacity)	125	87.5	ICC-51, MC-330	150; see Note 4
Sulfur dioxide (tanks over 1,200 gallons water capacity)	125	87.5	ICC-51, MC-330	125; see Note 4
Sulfur dioxide (optional portable tank 1,000-2,000 pounds water capacity, fusible plug)	125	See Note 6	ICC-51	225

NOTE 1: Maximum filling density for liquefied gases is hereby defined as the percent ratio of the weight of gas in the tank to the weight of water that the tank will hold. For determining the water capacity of the tank in pounds, the weight of a gallon (231 cubic inches) of water at 60°F. in air shall be 8.32828 pounds.

NOTE 2: See §§ 73.32 and 73.33 of this part for authority to use containers made prior to May 15, 1950.

NOTE 3: If cargo tanks and portable tank containers for carbon dioxide and nitrous oxide are designed to comply with the "Rules for Containers for Gases and Liquids at Temperatures of Minus 20 Degrees Fahrenheit and Below" of the A. S. M. E. Code, the design working pressure may be reduced to 100 psig or the controlled pressure, whichever is greater.

NOTE 4: A corrosion factor shall be applied in the design of tanks for sulfur dioxide and chlorine. (See § 78.336-3 (a).)

NOTE 5: Unlagged cargo tanks and portable tank containers for liquid anhydrous ammonia may be filled to 87.5 percent by volume provided the temperature of the anhydrous ammonia being loaded into such tanks is determined to be not lower than 30°F. or provided the filling of such tanks is stopped at the first indication of frost or ice formation on the outside surface of the tank and is not resumed until such frost or ice has disappeared

NOTE 6: Tanks equipped with fusible plugs must be filled by weight.

NOTE 7: Tanks must be filled by weight.

NOTE 8: Chlorine cargo tank motor vehicles may be shipped only if the contents are to be unloaded at one unloading point.

(b) Maximum permitted filling densities for cargo tanks and portable tank containers for transportation of liquefied petroleum gases are as follows:

Maximum specific gravity of the liquid material at 60° F.	Maximum permitted filling density in percent of the water-weight capacity of the tanks		Maximum permitted filling density by volume
	1200 gallons or less	Over 1200 gallons	
	Percent	Percent	
0.473—0.480	38	41	See Note 1
0.481—0.488	39	42	
0.489—0.495	40	43	
0.496—0.503	41	44	
0.504—0.510	42	45	
0.511—0.519	43	46	
0.520—0.527	44	47	
0.528—0.536	45	48	
0.537—0.544	46	49	
0.545—0.552	47	50	
0.553—0.560	48	51	
0.561—0.568	49	52	
0.569—0.576	50	53	
0.577—0.584	51	54	
0.585—0.592	52	55	
0.593—0.600	53	56	
0.601—0.608	54	57	
0.609—0.617	55	58	
0.618—0.626	56	59	
0.627—0.634	57	60	

NOTE 1: Same filling density as permitted by weight, except when using fixed length dip tube or other fixed maximum liquid level indicators (paragraph (f) of this section), in which case the maximum permitted filling density shall not exceed 97 percent of the maximum permitted filling density by weight contained in the table.

(1) The design working pressure of cargo tanks and portable tank containers for liquefied petroleum gases shall be in accordance with the following classification:

Maximum vapor pressure of liquefied petroleum gas at 115° F., which may be placed in tank (psig)	Minimum design working pressure (psig)
125...	125
187...	187
250...	250
Over 250 see Note 1 to subpar. (b) (1) of this section.	

NOTE 1: Gases with vapor pressure exceeding 250 psig shall be placed in tanks with design working pressure increased above 250 psig by increments of 62.5 psig.

(c) The loading of liquefied gases into cargo tanks and portable tank containers shall be determined by weight or by suitable liquid level gauging device. In either case the liquid portion of the gas shall not fill the tank at 105°F. if the tank be lagged, nor at 115°F. if the tank be unlagged, except that this requirement shall be waived for the shipment of carbon dioxide and nitrous oxide in tanks (which are required to be equipped with suitable pressure controlling devices) which may be charged to a level corresponding to 95 percent of the volumetric capacity of the tank.

(d) If the loading of cargo tanks and portable tank containers with liquefied gases is to be determined by weight, the gross weight shall be checked after the filling line is disconnected in each instance. The gross weight shall be calculated from the tank capacity and tare weight set forth on the metal plate required by the specification, and the maximum filling density permitted for the material being loaded into the tank as set forth in the table, paragraph (a) (1) of this section.

(e) If the loading of cargo tanks and portable tank containers with liquefied gases is to be determined by adjustable liquid level device, each tank and each compartment thereof shall have a thermometer well, so that the internal liquid temperature can easily be determined, and the amount of liquid in the tank shall be corrected to a 60°F. basis Liquid levels shall not exceed a level corresponding to the maximum filling density permitted for the material being loaded into the tank as set forth in the table in paragraph (a) (1) of this section.

(f) When the loading of cargo tanks and portable tank containers with liquefied gases is determined only by fixed maximum liquid level indicator, the device shall be arranged to function at a level not to exceed the maximum permitted volume prescribed by the table, paragraph (a) (1) of this section Loading shall be stopped when the device functions.

(g) Containers, the liquid level of which has been determined by means of a fixed length dip tube gauging device, shall not be acceptable for stowage as cargo on vessels in commerce subject to the jurisdiction of the United States Coast Guard. Nothing contained in this rule shall be so construed as to prohibit the transportation on car floats or car ferries of motor vehicles laden with containers nor cargo tanks the liquid level of either of which has been determined by means of fixed length dip tube devices.

(h) Each cargo tank and portable tank container, except tanks filled by weight, shall be equipped with one or more of the following gauging devices which indicate accurately the maximum permitted liquid level: (Additional gauging devices may be installed but may not be used as primary controls for filling of cargo tanks and portable tank containers. Gauge glasses' shall not be permitted to be installed on any cargo tank or portable tank container).

Kind of gas	Permitted gauging device
Anhydrous ammonia	Rotary tube; adjustable slip tube; fixed length dip tube.
Anhydrous dimethylamine	None.
Anhydrous monomethylamine	None.
Anhydrous trimethylamine	None.
Carbon dioxide, liquefied	Rotary tube; adjustable slip tube; fixed length dip tube.
Chlorine	None.
Dichlorodifluoromethane	None.
Dichlorodifluoromethane-dichlorotetrafluoroethane mixture	None.
Dichlorodifluoromethane-monofluorotrichloromethane mixture	None.
Liquefied petroleum gases	Rotary tube; adjustable slip tube; fixed length dip tube.
Methyl chloride	Fixed length dip tube.
Monochlorodifluoromethane	None.
Nitrous oxide	Rotary tube; adjustable slip tube; fixed length dip tube.
Sulfur dioxide	Fixed length dip tube.

(1) The design pressure of the liquid level gauging devices shall be at least equal to the design working pressure of the tank.

(2) All liquid level gauging devices, except on tanks provided with fixed maximum level in indicators, shall be legibly and permanently marked in increments of not more than 20 Fahrenheit degrees to indicate the maximum levels to which the tank may be filled with liquid at temperatures above 20°F. except that gauging devices on tanks for carbon dioxide and nitrous oxide may be marked in increments of not more than 25 psig. In the event that it is impracticable to put these markings on the gauging device, this information shall be marked on a suitable plate affixed to the tank in a location adjacent to the gauging device.

(3) Liquid level gauging devices which are so constructed that the outward flow of tank contents exceeds that passed by a No. 54 drill size opening, shall be equipped with excess-flow valves. Exception: Not required on gauging devices when used on tanks in carbon dioxide service.

(4) A fixed-length dip tube gauging device, when used, shall consist of a dip pipe of small diameter equipped with a valve at the outer end, and extending into the tank to a specified fixed length. On horizontally mounted cylindrical tanks the fixed length to which the tube extends into the tanks shall be such that the device will function to indicate when the liquid at a point equidistant from the heads of the tank in a vertical plane containing the longitudinal axis of the tank, reaches the maximum level permitted by this section except that on tanks for liquefied petroleum gases the device should be set to function when the liquid reaches the maximum level at 40°F. when charged in accordance with the authorized filling density. On spherical tanks and on vertically mounted cylindrical tanks the fixed length to which the tube extends into the tank shall be such that the device will function to indicate when the liquid at a point on the vertical axis of the tank in its normal position reaches the maximum level permitted by this section except that on tanks for liquefied petroleum gases the device should be set to function when the liquid reaches the maximum level at 40° F. when charged in accordance with the authrorized filling density.

(i) Each tank shall be provided with one or more safety devices which, unless otherwise specified, shall be safety relief valves of the springloaded type and they shall be arranged to discharge upward and unobstructed to the outside of the protective housing in such a manner as to prevent any impingement of escaping gas upon the tank, except that for chlorine tanks, protective housing shall be as required in § 78.336-5, and safety valve as required in sub-paragraph (11) of this paragraph.

(1) Safety relief valves on any tank shall be set to start-to-discharge at a pressure not in excess of 110 percent of the design working pressure of the tank and shall have a total relieving capacity sufficient to prevent a maximum pressure in the tank of more than 120 percent of the design working pressure, using the heat input as determined by Fetterly's formula.[1] The required relieving capacity of safety relief valves for lagged tanks shall be based upon the heat input to a bare tank, unless insulation is covered by a sheet metal jacket of not less than 16 gauge nominal thickness.

(2) The start-to-discharge pressure of safety relief valves shall be not less than the values given in the following table:

Kind of gas	Minimum start-to-discharge pressure (psig)
Anhydrous ammonia	265.
Anhydrous dimethylamine	150.
Anhydrous monomethylamine	150.
Anhydrous trimethylamine	150.
Carbon dioxide, liquefied	Not specified.
Chlorine	225.
Dichlorodifluoromethane	150.
Dichlorodifluoromethane-dichlorotetrafluoroethane mixture	150.
Dichlorodifluoromethane-monofluorotrichloromethane mixture	150.
Liquefied petroleum gases	90 percent of the design working pressure of tank.
Methyl chloride	150.
Monochlorodifluoromethane	250.
Nitrous oxide	Not specified.
Sulfur dioxide:	
Up to 1,200 gallons water capacity tank	120.
Over 1,200 gallons water capacity tank	110.

(3) Each safety relief valve shall be plainly and permanently marked with the pressure in psig at which it is set to discharge, with the actual rate of discharge of the device in cubic feet per minute of the gas at 60°F. and atmospheric pressure, and with the manufacturer's name and catalog number. The rated discharge capacity of the device shall be determined at a pressure of 120 percent of the design working pressure of the tank.

(4) Connections to safety relief valves shall be of sufficient size to provide the required rate of discharge through the safety relief valves.

(5) Safety relief valves shall be arranged so that the possibility of tampering will be minimized; and if the pressure setting or adjustment is external the safety relief valves shall be provided with suitable means for sealing the adjustment.

(6) No shut-off valves shall be installed between the safety relief valves and the tank except, in cases where two or more safety relief valves are installed on the same tank, a shut-off valve may be used where the arrangement of the shut-off valve or valves is such as always to afford full required capacity flow through at least one safety relief valve.

(7) Safety relief valves shall have direct communications with the vapor space of the tank.

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[1] Copies of Fetterly's formula may be obtained from the Bureau of Explosives.

(8) Any portion of liquid piping or hose which at any time may be closed at each end must be provided with a safety relief valve to prevent excessive hydrostatic pressure. This safety relief valve must not have an intervening shut-off valve installed.

(9) Additional restrictions as specified in Notes 1, 2, and 3 of this subparagraph apply to safety relief devices on tanks for carbon dioxide or nitrous oxide.

NOTE 1: The maximum operating pressure in the tank may be regulated by the use of one or more pressure controlling devices, which devices shall not be in lieu of the safety relief valve required in paragraph (i) of this section.

NOTE 2: All safety devices shall be so installed and located that the cooling effect of the contents will not prevent the effective operation of the device.

NOTE 3: In addition to safety relief valves required by paragraph (i) of this section each tank for carbon dioxide may be equipped with one or more frangible disc devices of suitable design set to function at a pressure not exceeding two times the design working pressure of the tank.

(10) Subject to conditions of subparagraph (a) (1) of this section for sulfur dioxide optional portable tank 1,000-2,000 pounds water capacity—225 psig, one or more fusible plugs approved by the Bureau of Explosives may be used in lieu of safety relief valves of the spring-loaded type. The fusible plug or plugs shall have total relieving capacity as determined by the use of Fetterly's formula sufficient to prevent a pressure rise in the tank of more than 120 percent of the design working pressure. If the tank is over thirty inches long, both ends must have the total specified safety discharge area.

(11) Safety relief valve on chlorine tank motor vehicles shall conform with the standard of The Chlorine Institute, Inc. Dwg. D-13105-Rev. "D," dated December 18, 1952.

(j) Storage containers for liquefied petroleum gas for permanent installation on consumer premises may be shipped by private motor carrier only under the following conditions:

(1) The containers shall comply with the construction requirements of one of the following pressure vessel codes and shall be marked to indicate compliance as specified in the code:

The 1952 Edition of the Unfired Pressure Vessel Code of the A. S. M. E., no revisions.

The 1950 Edition of the Unfired Pressure Vessel Code of the A. S. M. E., no revisions.

The 1949 Edition of the Unfired Pressure Vessel Code of the A. S. M. E.

The 1951 Edition of the joint Unfired Pressure Vessel Code of the A. P. I. and A. S. M. E., no revisions.

The 1943 Edition of the joint Unfired Pressure Vessel Code of the A. P. I. and A. S. M. E.

(2) Each container shall be equipped with safety devices in compliance with the requirements for safety devices on aboveground containers as specified in the National Board of Fire Underwriters Pamphlet No. 58 "Standards for the Design, Installation and Construction of Containers and Pertinent Equipment for the Storage and Handling of Liquefied Petroleum Gases," 1949 Edition.

(3) The containers shall be so braced or otherwise secured on the vehicle as to prevent relative motion while in transit. Valves or other fittings shall be adequately protected against injury during transportation. (See § 77.834 (g).)

(4) Except as provided in subparagraph (j) (5) of this paragraph, containers shall not be shipped when charged with liqufied petroleum gas to more than 5 percent of their water capacity.

(5) Storage containers of less than 1042 pounds water capacity (125 gallons) may be shipped when charged with liquefied petroleum gas in compliance with I. C. C. filling density.

(k) For manifolding of cargo tank containers see § 73.301 (f).

SUBPART G—POISONOUS ARTICLES; DEFINITION AND PREPARATION

§ **73.325 Classes of poisonous articles.** (a) Poisonous articles for the purpose of Parts 71-78 are divided into four classes according to degree of hazard in transportation.

(1) Extremely dangerous poison—class A.

(2) Less dangerous poison—class A.

(3) Tear gases or irritating substances—class C.

(4) Radioactive materials—class D.

§ **73.326 Extremely dangerous poisons, Class A, poison gas label; definition.** (a) For the purpose of Parts 71-78 extremely dangerous poisons, class A, are poisonous gases or liquids of such nature that a very small amount of the gas, or vapor of the liquid, mixed with air is dangerous to life. This class includes the following:

(1) Bromacetone.

(2) Cyanogen.

(3) Cyanogen chloride containing less than 0.9 percent water.

(4) Diphosgene.

(5) Ethyldichlorarsine.

(6) Hydrocyanic acid (see Note 1 of this paragraph).

(7) Lewisite.

(8) Methyldichlorarsine.

(9) Mustard gas.

(10) Nitrogen peroxide (tetroxide).

(11) Phenylcarbylamine chloride.

(12) Phosgene (diphosgene).

NOTE 1: Diluted solutions of hydrocyanic acid of not exceeding 5 percent strength are classed as poisonous articles, class B (see § 73.343 of this part).

(b) Poisonous gases or liquids, class A, as defined in paragraph (a) of this section, except as provided in § 73.331 of this part, must not be offered for transportation by rail express.

§ **73.327 Packing.** (a) Cylinders used must comply with the provisions of §§ 73.34 and 73.301 (g) of this part.

(b) Closing and cushioning. All containers must be tightly and securely closed. Inside containers must be cushioned as prescribed, or in any case when necessary to prevent breakage or leakage.

(c) No class A poisons in cargo tanks. No "extremely dangerous poison, class A," may be loaded into or transported in any cargo tank.

(d) It shall not be permissible to transport class A poison if there be any interconnecting means of any character between the containers.

§ **73.328 Poisonous gases and liquids not specifically provided for.** (a) Poisonous gases and liquids, as defined in § 73.326, other than those for which special requirements are prescribed, must be packed in specification containers as follows:

(1) Spec. 33[1] or 3D. Metal cylinders of not over 125 pounds water capacity (nominal). Gaskets if used between the protection cap and neck of cylinder must be renewed

for each shipment even though they may appear to be in good condition Cylinders not fitted with valve protection extension ring must be packed in wooden boxes complying as to construction, marking, and labeling, with the requirements of § 73.25 of this part.

§ 73.329 **Bromacetone; chlorpicrin and methyl chloride mixtures.** (a) Bromacetone. Bromacetone, when offered for transportation by carriers by rail freight, highway, or water, must be packed in specification containers as follows:

(1) As prescribed in § 73.328.

(2) Spec. 15A, 15B, 15C, or 16A. Wooden boxes with inside glass bottles or tubes in hermetically sealed metal cans in corrugated fiberboard cartons, spec. 2C. Bottles must contain not over 1 pound of liquid each, must be filled to not over 95 percent capacity, must be tightly and securely closed, and must be cushioned in cans with at least ½ inch of absorbent material. Cans must be made of metal at least 32 gauge United States standard. Total amount of liquid in outside box must not exceed 24 pounds.

(b) **Chlorpicrin and methyl chloride mixtures.** Chlorpicrin and methyl chloride mixtures, in addition to containers prescribed in § 73.328, when offered for transportation by carriers by rail freight, highway, or water, may be shipped in specification containers as follows:

(1) Spec 3A, 3AA, 3B, 3C, 3E, 4A, 4B, 4BA, or 4C not over 250 pounds water capacity (nominal). Valves or other closing devices must be protected, to prevent injury in transit, by screw-on metal caps or by packing the cylinders in strong boxes or crates. Cylinders having a wall thickness of less than 0.10 inch must be packed in boxes or crates (see § 73.25).

§ 73.330 **Chemical ammunition.** (a) Projectiles, shells, bombs, and grenades containing poisonous gases or liquids, class A § 73.326 of this part, but not equipped or packed with ignition elements, bursting charges, detonating fuzes, or explosive components, may only be shipped by, for, or to the Departments of the Army, Navy, and Air Force of the United States Government. Shipments must be packed and marked as required by their regulations, and packages must be labeled with the "Poison Gas" label and marked "NON-EXPLOSIVE" and with the name of the contents. (See §§ 73.53 (r) and 73.59 of this part for explosive chemical ammunition).

(b) Chemical ammunition containing poisonous liquids or gases, class A, must not be offered for transportation by rail express.

§ 73.331 **Gas identification sets.** (a) Gas identification sets containing poisonous liquids and gases, class A, and poisonous articles, class C, and chlorine when offered for transportation by carriers by rail freight, rail express, highway, or water must be packed in spec. 15A or 15B. Wooden boxes, under the following conditions:

(1) Gas identification sets containing poisonous liquids and gases, class A, and poisonous articles, class C, may be shipped in amounts not exceeding 5 mils, if a liquid, or 5 grams, if a solid, when mixed with or absorbed in activated charcoal or silica gel, or other absorbent medium, and packed in strong glass bottles of not less than 4-fluid-ounces capacity. The poisonous gases, class A, and chlorine may be shipped if the gas itself is absorbed in activated charcoal or silica gel, or other absorbent medium, this material to be filled into 4-ounce bottles as above; each bottle as herein specified must be surrounded with appropriate absorbent cushioning material, and inclosed in a hermetically sealed metal can; each can must be surrounded on all sides by at least 1 inch of dry, fine sawdust or wood pulp; the cans must be packed in an outside wooden box, spec. 15A or 15B; the bottles must be closed with ground-in glass stoppers securely fastened; the cushioning material around the bottle must be at least 1 inch thick; the cans must be made from metal of thickness not less than 30 gauge, United States standard; and there must be not more than a total of 100 grams or mils, or a combination of both, in each outside wooden box.

(b) Gas identification sets containing poisonous liquids or gases, class A and class C, when offered for transportation by carriers by rail freight, rail express, highway, or water must be packed for shipment as follows:

(1) The liqjuids or liquefied gases in hermetically sealed glass tubes containing not to exceed 40 cubic centimeters each; each tube securely cushioned and packed in an individual mailing tube with screw-thread metal cover; not more than 12 of such mailing tubes, cushioned with corrugated fiberboard, packed in a closed fiberboard container; and not to exceed 4 such fiberboard containers, containing an aggregate of not to exceed 48 glass tubes, cushioned and packed in an outside steel cylinder of not less than 0.145-inch wall thickness, which is closed by a plate, bolted to a flange, welded to cylinder wall. Suitable gasket shall be placed between flange and head plate, and closure shall be such as to prevent leakage of any gas.

§ 73.332 **Hydrocyanic acid, liquid (prussic acid) and hydrocyanic acid liquefied.** (a) Hydrocyanic acid, liquid (prussic acid) and hydrocyanic acid liquefied, must be packed in specification containers as follows:

(1) As prescribed in § 73.328.

(2) Spec. 3A480, 3AA480, or 3A480X. Metal cylinders of not over 278 pounds water capacity (nominal); valve protection cap must be used and be at least 3/16 inch thick, gas-tight, with 3/16 inch faced seat for gasket and with United States standard form thread; the cap must be capable of preventing injury or distortion of the valve when it is subjected to an impact caused by allowing cylinder, prepared as for shipment, to fall from an upright position with side of cap striking a solid steel object projecting not more than 6 inches above floor level.

(b) Cylinders must be charged with not more than 0.6 pound of liquid for 1-pound water capacity of cylinder. Each filled cylinder must be tested for leakage before shipment and must show absolutely no leakage; this test must consist in passing over the closure of the cylinder, without the protection cap attached, a piece of Guignard's sodium picrate paper to detect any escape of hydrocyanic acid from the cylinder. Other equally efficient test methods may also be used in lieu of the picrate paper.

(c) Liquid hydrocyanic acid completely absorbed in inert material may also be shipped in specification containers as follows:

(1) Spec. 15A. Wooden boxes with inside containers consisting of metal cans, spec. 2N, not over 14 pounds water capacity each. The liquid contents of each can must not exceed 0.33 pound of liquid for 1-pound water capacity of the can. Each can containing 4 ounces or more of liquid must be fitted with fiber caps not less than 0.08 inch thick flanged about 1 inch and fitting snugly over each end of the can. Each can must be tested for leakage after being filled and again after being maintained at ordinary room temperature for a period of at least three weeks. Each can must have its outer surface protected against rust by the use of enamel or lacquer, or each can must be completely wrapped in waterproof paper.

(2) The box lining must consist of not more than two pieces of waterproof paper, one piece completely surrounding the contents and running lengthwise of the box, and the other piece completely surrounding the contents and running crosswise of the box. In each instance, the wrapping must overlap at least 4 inches.

§ 73.333 **Phosgene or diphosgene.** (a) Phosgene or diphosgene must be packed in specification containers as follows:

(1) As prescribed in § 73.328 of this part; filling density (see § 73.308, Note 12 of this part) must not exceed 125 percent and a cylinder must not contain more than 150 pounds of phosgene.

(2) Spec. 106A500 or 106A500X. Tank cars. Each container must be equipped with valve protection caps, gastight, which must be approved by the Bureau of Explosives; containers must not be equipped with safety devices of any type; containers must be filled so that they will not be liquid full at 130°F. Authorized only for phosgene.

NOTE 1: Tanks complying with Spec 106A500 or 106A500X, may be transported on trucks or semi-trailers only, when securely chocked or clamped thereon to prevent shifting, and provided adequate facilities are present for handling tanks where transfer in transit is necessary.

(b) Each filled cylinder must be tested for leakage before shipment and must show absolutely no leakage; this test must consist in immersing the cylinder and valve, without the protection cap attached, in a bath of water at a temperature of approximately 150° F. for at least thirty minutes, during which time frequent examinations must be made to note any escape of gas. The valve of the cylinder must not be loosened after this test and before shipment.

§ 73.334 **Hexaethyl tetraphosphate, parathion, tetraethyl dithio pyrophosphate, and tetraethyl pyrophosphate, mixtures with compressed gas.** (a) Hexaethyl tetraphosphate, parathion, tetraethyl dithio pyrophosphate, and tetraethyl pyrophosphate, mixtures with compressed gas, containing not more than 10 percent by weight of hexaethyl tetraphosphate, parathion, tetraethyl dithio pyrophosphate, or tetraethyl pyrophosphate must be packed in specification containers as follows:

(1) Spec. 3A300, 3AA300, 3B300, 4A300, 4B240, or 4BA240. Metal cylinders, charged with not more than 5 pounds of the mixture and to a maximum filling density of 80 per cent of the water capacity. Cylinders must not be equipped with eduction tubes or fusible plugs. Valves must be of a type acceptable to the Bureau of Explosives.

(b) Cylinders must be packed in strong wooden boxes with valves or other closing devices protected from injury, with not more than twelve cylinders in one outside wooden box. A single-trip outside fiberboard box may be used when not more than four such cylinders are to be shipped in one outside container. Valves must be adequately protected. Box and valve protection must be of strength sufficient to protect all parts of inside containers and valves from deformation or breakage resulting from a drop of at least six feet onto a concrete floor, impacting at the weakest point.

§ 73.335 Police grenades. (a) Police grenades containing poisonous gases or liquids, class A, must be packed in specification containers as follows:

(1) Spec. 15A, 15B, or 15C. Metal-strapped wooden boxes. Each grenade must be individually inclosed in a corrugated fiberboard carton, spec. 2C, and when so packed must be able to withstand without leakage a drop of 5 feet on concrete. Grenades must consist of copper shell containing securely closed glass bottles or tubes containing not over 50 cubic centimeters of poisonous material. Each outside container may contain not over 24 grenades and weigh not over 75 pounds gross.

(b) Pending approval by the Commission of regulations classifying the numerous devices within the general descriptions of this section, and providing appropriate restrictions to be observed in the transportation thereof, no shipment of packages containing articles under this section shall be made until samples thereof have been examined by the Bureau of Explosives or by other competent testing laboratory in the presence of representative of the Bureau of Explosives, and the shipment is shown to possess such resistance to shocks of transportation and protection against leakage of contents as are afforded by standard types of packages described in Part 78, and the packages are labeled or marked to show compliance with this part.

§ 73.336 **Nitrogen dioxide, liquid (nitrogen peroxide, tetroxide).** (a) Nitrogen dioxide, liquid (nitrogen peroxide, tetroxide), must be packed in specification containers as follows:

(1) As prescribed in § 73.328 of this part.

(2) Spec. 3A480 or 3AA480 or 25[1]. Metal cylinders with valve removed; valve opening to be closed by means of a solid metal plug with tapered thread properly luted to prevent leakage; valve protection cap must be used and be at least 3/16 inch thick, gastight, with 3/16 inch faced seat for gasket and with United States standard form thread. Use of this container will be permitted because of the present emergency and until further order of the Commission.

(3) Spec. 106A500 or 106A500X. Tank cars. Each container must be equipped with valve protection caps, gastight, which must be approved by the Bureau of Explosives; containers must not be equipped with safety devices of any type; containers must be filled so that they will not be liquid full at 130°F.

NOTE 1: Tanks complying with Spec. 106A500 or 106A500X may be transported on trucks or semi-trailers only, when securely chocked or clamped thereon to prevent shifting, and provided adequate facilities are present for handling tanks where transfer in transit is necessary.

§ 73.337 **Nitric oxide.** (a) Nitric oxide must be packed in specification containers as follows:

(1) Spec. 3A, 3AA, or 3E1800 cylinders designed and marked for a service pressure of 1800 pounds per square inch, or higher, charged to a pressure of not more than 750 pounds per square inch at 70°F. Cylinders must be equipped with a valve of stainless steel and valve seat of material which will not be deteriorated by contact with nitric oxide or nitrogen dioxide. Containers or valves must not be equipped with safety devices of any type. Valve outlets must be sealed by a solid threaded cap or plug and an inert gasketing material.

(2) Spec. 3E1800 cylinders must be packed in strong wooden boxes of such design as to protect valves from injury or accidental functioning under conditions incident to transportation. Each outside shipping container must be plainly marked "inside containers comply with prescribed specifications."

(3) Spec. 3A and 3AA cylinders must have their valves protected by metal caps securely attached to the cylinders and of sufficient strength to protect the valves from injury during transit, or by packing in strong wooden boxes of such design as to protect valves from injury or accidental functioning under conditions incident to transportation. Each outside shipping container must be plainly marked "inside containers comply with prescribed specifications."

§ 73.343 **Less dangerous poisons, class B, liquid or solid, poison label; definition.** (a) For the purpose of Parts 71-78 and except as otherwise provided in this part class B poisons are substances, liquids or solids (including pastes and semi-solids), other than classes A, C, or D poisons which are known to be so toxic to man as to afford a hazard to health during transportation, or which, in the absence of adequate data on human toxicity, are presumed to be toxic to man because they fall within any one of the following categories when tested on laboratory animals:

(1) Oral toxicity. Those which produce death within 48 hours in half or more than half of a group of 10 or more white laboratory rats weighing 200 to 300 grams at a single dose of 50 milligrams or less per kilogram of body weight, when administered orally.

(2) Toxicity on inhalation. Those which produce death within 48 hours in half or more than half of a group of 10 or more white laboratory rats weighing 200 to 300 grams, when inhaled continuously for a period of one hour or less at a concentration of 2 milligrams or less per liter of vapor, mist, or dust, provided such concentration is likely to be encountered by man when the chemical product is used in any reasonable foreseeable manner.

(3) Toxicity by skin absorption. Those which produce death within 48 hours in half or more than half of a group of 10 or more rabbits tested at a dosage of 200 milligrams or less per kilogram body weight, when administered by continuous contact with the bare skin for 24 hours or less.

(b) The foregoing categories shall not apply if the physical characteristics or the probable hazards to humans as shown by experience indicate that the substances will not cause serious sickness or death. Neither the display of danger or warning labels pertaining to use nor the toxicity tests set forth above shall prejudice or prohibit the exemption of any substances from the provisions of Parts 71-78.

§ 73.344 **Packing for class B poisons, liquid.** (a) Closing and cushioning. All containers must be tightly and securely closed. Inside containers must be cushioned as prescribed, or in any case when necessary to prevent breakage or leakage.

(b) Outage. Outage for containers of liquid poison for transportation by carriers by rail freight, rail express, highway, or water must be as follows:

(1) Containers must not be entirely filled. Sufficient interior space must be left vacant to prevent leakage or distortion of containers due to the expansion of the contents from increase of temperature during transit.

(2) The proper vacant space (outage) in a tank car or other shipping container depends on the coefficient of expansion of the liquid and the maximum increase of temperature to which it will be subjected in transit. Outage must be calculated to the total capacity of the container.

(3) Liquid poison must not be loaded into domes of tank cars.

(4) In tank cars, outage must be calculated to percentage of the total capacity of the tank, i. e., shell and dome capacity combined. If the dome of the tank car does not provide sufficient outage, then vacant space must be left in the shell to make up the required outage.

(5) The outage for tank-cars must not be less than 1 percent.

(6) No cargo tank or compartment thereof used for the transportation of any liquid poison shall be completely filled; sufficient space shall be left vacant in every case to prevent leakage from or distortion of any such cargo tank by expansion of the contents due to rise in temperature in transit, and such free space (outage) shall be sufficient in every case so that such cargo tank shall not become entirely filled with the liquid at 130°F.

§ 73.345 **Exmeptions for poisonous liquids, class B.** (a) Poisonous liquids, class B, as defined in § 73.343, except those as enumerated in paragraph (b) of this section, or as provided for in § 73.359 (c), in tightly closed inside containers, securely cushioned when necessary to prevent breakage and packed as follows, are exempt from specification packaging, marking, and labeling requirements, except that marking name of contents on outside container is required for shipments via carrier by water. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

(1) In glass or earthenware containers not over 1 quart capacity each, or in metal containers not over 1 gallon capacity each, packed in strong outside wooden boxes or barrels.

(2) In glass or earthenware containers not over 1 pint capacity each, or in metal containers not over 1 quart capacity each, packed in strong outside fiberboard boxes.

(b) The following articles in any quantity are not exempt under the provisions of paragraph (a) of this section:

(1) Aniline oil.

(2) Hydrocyanic acid solutions.

(3) Methyl bromide.

(4) Motor fuel anti-knock compound.

(5) Phenyldichlorarsine.

(6) Tetraethyl lead.

(7) Thiophosgene.

(8) Chlorpicrin and chlorpicrin mixtures containing no compressed gas or poisonous liquid, class A.

(9) Parathion and parathion mixtures containing more than 25% parathion by weight.

(10) Hexaethyl tetraphosphate and hexaethyl tetraphosphate mixtures containing more than 25% hexaethyl tetraphosphate by weight.

(11) Methyl parathion and methyl parathion mixtures containing more than 25% methyl parathion by weight.

(12) Tetraethyl dithio pyrophosphate and tetraethyl dithio pyrophosphate mixtures containing more than 25% tetraethyl dithio pyrophosphate by weight.

(13) Tetraethyl pyrophosphate and tetraethyl pyrophosphate mixtures containing more than 25% tetraethyl pyrophosphate by weight.

(14) ^{4}Chloro-o-toluidine hydrochloride.

§ 73.346 **Poisonous liquids not specifically provided for..** (a) Poisonous liquids as defined in § 73.343, other than those for which special requirements are prescribed, must be packed in specification containers of a design and constructed of materials that will not react dangerously with or be decomposed by the chemical packed therein, as follows:

(1) Spec. 5, 5A, 5B, or 5C. Metal barrels or drums, with openings not exceeding 2.3 inches in diameter.

(2) Spec. 17C or 17E. Metal drums (single-trip containers), with openings not exceeding 2.3 inches in diameter.

(3) Spec. 37B. Metal drums (single-trip containers), welded side seams, openings not over 2.3 inches in diameter, capacity not over 10 gallons.

(4) Spec. 37A or 37B. Metal drums (single-trip containers), with welded side seams, not over 5 gallons; authorized for pastes only.

(5) Spec. 10A, 10B, or 10C. Wooden barrels or kegs.

(6) Spec 11A or 11B. Wooden barrels or kegs with glass or earthenware inside containers, not over 1 gallon capacity each, or with metal inside containers not over 2 gallons capacity each.

(7) Spec. 12B. Fiberboard boxes with glass or earthenware inside containers not over 1 quart capacity each, or with metal inside containers not over 1 gallon capacity each. Packages containing glass or earthenware containers must not weigh over 65 pounds gross.

(8) Spec. 12D. Fiberboard boxes with inside container which must be glass or earthenware not over one gallon each; authorized for not more than 75 pounds gross weight; not to contain more than 4 such inside containers if their capacity is greater than 5 pints each. Use of this container will be permitted because of the present emergency and until further order of the Commission.

(9) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with glass or earthenware inside containers not over 1 gallon capacity each, except that inside containers up to 3 gallons are authorized when only one is packed in each outside container; or with metal inside containers, not over 10 gallons capacity each.

(10) Spec. 103, 103-W, 103A, 103A-W, 104, 104-W, 105A100, 105A100-W, 105A300-W, 105A400-W, 105A-500-W, 105A600-W, or ARA-IV-A[1]. Tank cars.

(11) Cylinders as prescribed for any compressed gas, except acetylene, are also authorized.

(12) Spec MC 300, MC 301, MC 302, MC 303, MC 310 or MC 311. Tank motor vehicles.

(13) Spec. 1A, 1D, or 1E. Glass carboys in wooden boxes or plywood drums.

(14) Spec. 12B. Fiberboard boxes with not more than one inside glass container of not over 1 gallon capacity, securely cushioned. Completed package, with glass container filled with water, when closed for shipment, must be capable of withstanding six four-foot drops onto solid concrete in the order bottom, four sides, and top without breakage.

(15) Spec. 21B. Fiber drums, with inside glass containers not over one gallon capacity each.

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[1] Use of existing tank cars authorized, but new construction not authorized.

§ 73.347 **Aniline oil.** (a) Aniline oil must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with metal inside containers not over 10 gallons capacity each, or glass bottles not over 1 pound capacity each. Not more than 25 of these bottles shall be packed in any outside container.

NOTE 1: Because of the present emergency and until further order of the Commission glass bottles not over 5 pounds capacity each and not more than 6 of these bottles packed in one outside container are authorized.

(2) Spec. 103, 103W, 103A, or 103A-W. Tank cars.

(3) Spec. MC 300, MC 301, MC 302, or MC 303. Tank motor vehicles.

(4) Spec. 5, 5A, or 5B. Metal barrels or drums. Net weight in 110 gallon drums must not exceed 915 pounds.

(5) Spec. 17C. Metal drums (single-trip).

(6) Spec. 17E. Metal drums (single-trip) not over 5 gallons capacity each.

(7) Spec. 12B. Fiberboard boxes with metal inside containers not over 1 gallon capacity each; not to contain more than 4 such inside containers if their capacity is greater than 5 pints each.

(b) Openings in metal barrels or drums must not exceed 2.3 inches in diameter.

(1) Gaskets not less than one-eighth inch thick must be used at bung and filling holes. Gaskets must be made of hard fiber impregnated with glycerin, metal-covered cork, impregnated asbestos sheets, or metal-covered asbestos.

(c) Filled drums must be so placed that bungs will be subjected to hydrostatic head of oil contained therein for a period of not less than 12 hours.

(1) The exterior of filled drums must be carefully examined for evidence of aniline oil, any traces of which must be removed by washing off with water or, preferably, weak acetic acid. The space between rolling hoops immediately around the bung should be painted to aid in the detection of leaks at this point.

(d) All returnable drums must bear the following notice, "PREVENT DAMAGE TO FOODSTUFFS OR OTHER FREIGHT. DRAIN THIS DRUM THOROUGHLY. TIGHTEN BUNGS, WITH GASKET, SECURELY IN PLACE BEFORE RETURNING. USE NEW GASKETS WHEN NECESSARY. ANILINE OIL STAINS ON THE OUTSIDE OF DRUMS SHOULD BE WASHED OFF WITH WATER OR, PREFERABLY, WEAK ACETIC ACID," shellacked to head of drum near the consignee's name and address.

§ 73.348 **Arsenic acid.** (a) Arsenic acid must be packed in specification containers as follows:

(1) As prescribed in § 73.346 of this part. When shipped in metal barrels or drums, or tank motor vehicles or tank cars, without lead lining, the arsenic acid must contain not over 0.05 percent nitric acid.

(2) Spec. 1A, 1C, or 1D. Glass carboys in boxes or kegs which must be closed, and when reused must be reconditioned and tested, as provided in the specification.

§ 73.349 **Carbolic acid (phenol) liquid.** (a) Carbolic acid (phenol) liquid (liquid tar acid containing over 50 percent benzophenol), must be packed in specification containers as follows:

(1) As prescribed in § 73.346 of this part.

(2) Specification 1A, 1C, or 1D. Glass carboys in boxes or kegs, which must be closed, and when reused must be reconditioned and tested, as provided in the specification.

§ 73.350 **Chemical ammunition.** (a) Chemical ammunition consisting of projectiles, shells, bombs, grenades and other containers filled with gases, liquids, or chemicals, class B poison, without ignition elements, bursting charges, detonating fuzes, or other explosive components, must be packed for shipment in strong outside wooden or metal boxes. Boxes must be marked with name of contents and labeled as prescribed by this part for gases, liquids, or chemicals contained therein.

(b) Chemical ammunition, when shipped as such, must not be equipped or packed with explosive or ignition elements. (See §§ 73.53 (r) and 73.59 of this part for explosive chemical ammunition.)

§ 73.351 **Hydrocyanic acid solutions.** (a) Hydrocyanic acid solutions must be in glass bottles not over 1 pound capacity each for solutions of not over 5 percent strength and not over 5 pounds capacity each for solutions of not over 2 percent strength, and must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes.

(2) Spec. 11A or 11B. Wooden barrels or kegs.

§ 73.352 **Liquid sodium or potassium cyanide.** (a) Liquid sodium or potassium cyanide must be packed in specification containers as follows:

(1) Spec. 5, 5A, or 5B. Metal barrels or drums without galvanizing inside, with openings not exceeding 2.3 inches in diameter.

(2) Spec. 17E or 37B. Metal drums (single-trip), with welded side seams, with openings not exceeding 2.3 inches in diameter.

(3) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside glass or earthenware containers not over 1 gallon capacity each, or inside metal containers not over 10 gallons capacity each, and without galvanizing.

(4) Spec. 103, 103W, 103A, or 103A-W. Tank cars.

(5) Spec. MC 300, MC 301, MC 302 or MC 303. Tank motor vehicles.

§ 73.353 **Methyl bromide or mixtures of methyl bromide and ethylene dibromide, liquid.** (a) Methyl bromide or mixtures of methyl bromide and ethylene dibromide, liquid, must be packed in specification containers as follows:

(1) Spec. 5A. Metal drums not exceeding 30 gallons capacity or metal drums of bilge type not exceeding 33 gallons capacity and with openings not exceeding 2.3 inches in diameter. Use of these containers will be permitted because of the present emergncy and until further order of the Commission.

(2) Spec. 15A, 15B, 15C, 16A, 19A, or 12B. Wooden wire-bound wooden, or fiberboard boxes, with inside metal cans containing not over 1 pound each; outage required so cans shall not become liquid-full at 130°F. Cans must be of tinplate or lined with suitable material and must have concave or pressure ends. Cans must be able to withstand an interior pressure of 130 pounds per square inch gauge without evidence of leakage or permanent distortion.

(3) Spec. 3A225, 3AA225, 3B225, 3E1800, 4A225, 4B225, or 4BA225. Metal cylinders. Valves or other closing devices must be protected to prevent injury in transit by screw-on metal caps or by packing the cylinders in strong boxes or crates. Cylinders having a wall thickness of less than 0.08 inch must be packed in boxes or crates (see § 73.25).

(4) Spec. 4D300 or 4DA500. Metal spheres for aircraft use only, must be equipped with approved safety devices and must be packed in strong boxes or crates (see § 73.25).

(5) Spec. 105A100, 105A100-W, 105A300-W, 105A-400-W, 105A500-W, 105A600-W, 106A500, 106A500X, or 106A800. Tank cars.

(b) Outage must be sufficient to prevent tank car from becoming entirely filled with liquid at the following temperature: Spec. 105A100, 105A100-W, 105A300-W, 105A-400-W, 105A500-W, or 105A600-W at 105° F.; spec. 106A500, 106A500X, or 106A800 at 130°F.

(c) Outage must be sufficient to prevent cylinders or spheres from becoming entirely filled with liquid at

130°F. and when the vacant space (outage) is charged with nitrogen, carbon dioxide, or air the pressure in the cylinder or sphere at 130°F. must not exceed 5/4 the marked service pressure of the cylinder or sphere.

(d) Spec. 17C. Metal drums (single-trip) not over 5 gallons capacity each and having no opening exceeding 2.3 inches in diameter. Authorized only for mixtures containing not over 40 percent by weight of methyl bromide.

§ 73.354 **Motor fuel antiknock compound or tetraethyl lead.** (a) Motor fuel antiknock compound or tetraethyl lead must be packed in specification containers as follows:

(1) Spec. 15A. Wooden boxes with inside glass or earthenware containers of not over 1 pint capacity each, or metal cans, inclosed in hermetically sealed (soldered) metal cans, spec. 2A.

(2) Spec. 5 or 5A. Metal barrels or drums, with openings not exceeding 2.3 inches in diameter.

(3) Cylinders as prescribed for any compressed gas, except acetylene.

(4) Spec. 105A300-W. Tank cars. Stenciled on both sides of the tank "FOR MOTOR FUEL ANTIKNOCK COMPOUND ONLY." Tank cars not authorized for tetraethyl lead.

(5) MC 330 (see Note 1). Tank motor vehicles.

NOTE 1: MC 300, MC 301, MC 302, or MC 303 tank motor vehicles in motor fuel antiknock compound service prior to October 1, 1955 may be continued in service.

(b) Outage must be sufficient to prevent any container from becoming entirely filled with liquid at 130°F.

§ 73.355 **Phenyldichlorarsine.** (a) Phenyldichlorarsine must be packed in specification containers as follows:

(1) Spec. 5A. Metal barrels or drums, made of not less than 12 gauge steel, and limited to 30 gallons capacity, with openings not exceeding 2.3 inches in diameter. Each metal barrel or drum must be tested, before each filling to 20 pounds hydrostatic test.

§ 73.356 **Thiophosgene.** (a) Thiophosgene must be packed in specification containers as follows:

(1) Spec. 12B. Fiberboard boxes, with inside containers which must be tightly closed glass bottles not exceeding 1 pint capacity each, securely packed in absorbent incombustible cushioning material. Cushioning material must be capable of absorbing entire contents of the container.

(2) Spec. 15A or 15B. Wooden boxes, with inside containers which must be tightly closed glass bottles not exceeding 1 quart capacity each, securely packed in absorbent incombustible cushioning material. Cushioning material must be capable of absorbing entire contents of container.

§ 73.357 **Chlorpicrin and chlorpicrin mixtures containing no compressed gas or poisonous liquid, class A.** (a) Chlorpicrin. Chlorpicrin, when offered for transportation by carriers by rail freight, highway, or water, must be packed in specification containers as follows:

(1) Spec. 15A, 15B, 15C, or 16A. Wooden boxes with inside glass bottles or tubes in hermetically sealed metal cans in corrugated fiberboard cartons, spec. 2C. Bottles must contain not over 1 pound of liquid each, must be filled to not over 95 percent capacity, must be tightly and securely closed, and must be cushioned in cans with at least ½ inch of absorbent material. Cans must be made of metal at least 32 gauge United States standard. Total amount of liquid in outside box must not exceed 24 pounds.

(2) Spec. 12B. One-piece corrugated fiberboard boxes at least 200-pound test with inside glass bottles or tubes in hermetically sealed metal cans in individual unsealed one-piece corrugated fiberboard boxes, spec. 12B at least 200-pound test. Bottles must contain not over 1 pound of liquid each, must be filled to not over 95 percent capacity, must be tightly and securely closed, and must be cushioned in cans with at least ½ inch of absorbent material. Cans must be made of metal at least 32 gauge United States standard. Total amount of liquid in outside box must not exceed 12 pounds.

(3) Spec. 12B. One-piece corrugated fiberboard boxes at least 200-pound test with not more than one inside glass bottle or tube in a hermetically sealed metal can. Bottles must contain not over 1 pound of liquid, must be filled to not over 95 percent capacity, must be tightly and securely closed, and must be cushioned in cans with at least ½ inch of absorbent material. Cans must be made of metal at least 32 gauge United States standard.

(b) Chlorpicrin and mixtures of chlorpicrin containing no compressed gas or poisonous liquid, class A. Chlorpicrin and mixtures of chlorpicrin containing no compressed gas or poisonous liquid, class A, in addition to containers prescribed in paragraph (a) of this section, when offered for transportation by carriers by rail freight, highway, or water, may be shipped in specification containers as follows:

(1) Spec. 3A, 3AA, 3B, 3C, 3D, 3E, 4A, 4B, 4BA, or 4C. Metal cylinders of not over 250 pounds water capacity (nominal). Valves or other closing devices must be protected, to prevent injury in transit, by screw-on metal caps or by packing the cylinders in strong boxes or crates. Cylinders closed by means of solid plugs may have the plugs protected by metal collars. Cylinders having a wall thickness of less than 0.08 inch must be packed in boxes or crates (see § 73.25).

(2) Spec. 5A. Metal drums of not exceeding 33 gallons capacity with welded seams.

NOTE 1: Because of the present emergency and until further order of the Commission, drums not exceeding 55 gallons capacity with welded seams are authorized for mixtures containing not over 15 percent by volume of chlorpicrin.

(3) Spec. 17C or 17E. Metal drums (single-trip) with openings not exceeding 2.3 inches in diameter. Capacity not to exceed 30 gallons. Authorized only for chlorpicrin mixtures containing not to exceed 15 percent chlorpicrin by weight and only authorized for such mixtures not classed as flammable under these regulations.

(c) Chlorpicrin and mixtures of chlorpicrin containing no compressed gas or poisonous liquid, class A, when offered for transportation by rail express must be packed in specification containers as follows (also authorized for transportation by carriers by rail freight, highway, or water):

(1) Spec. 15A, 15B, 15C, or 16A. Wooden boxes with inside glass bottles or tubes in hermetically sealed metal cans in corrugated fiberboard cartons, spec. 2C. Bottles must contain not over 1 pound of liquid each, must be filled to not over 95 percent capacity, must be tightly and securely closed, and must be cushioned in cans with at least ½ inch of absorbent material. Cans must be made of metal at least 32 gauge United States standard. Total amount of liquid in outside box must not exceed 24 pounds.

(2) Spec. 15A. Wooden boxes, metal strapped, with chlorpicrin absorbed in an efficient absorbing material packed in hermetically sealed metal cans not exceeding 1 quart capacity each.

(3) Spec. 12B One-piece corrugated fiberboard boxes at least 200-pound test with inside glass bottles or tubes in hermetically sealed metal cans in individual unsealed one-piece corrugated fiberboard boxes, spec. 12B at least 200-pound test. Bottles must contain not over 1 pound of liquid each, must be filled to not over 95 percent capacity, must be tightly and securely closed, and must be cushioned in cans with at least ½ inch of absorbent material. Cans must be made of metal at least 32 gauge United States standard. Total amount of liquid in outside box must not exceed 12 pounds.

(4) Spec. 12B. One-piece corrugated fiberboard boxes at least 200-pound test with not more than one inside glass bottle or tube in a hermetically sealed metal can. Bottles must contain not over 1 pound of liquid, must be filled to not over 95 percent capacity, must be tightly and securely closed, and must be cushioned in cans with at least ½ inch of absorbent material. Cans must be made of metal at least 32 gauge United States standard.

§ 73.358 **Hexaethyl tetraphosphate, methyl parathion, parathion, tetraethyl dithio pyrophosphate, and tetraethyl pyrosphosphate, liquid.** (a) Hexaethyl tetraphosphate, methyl parathion, parathion, tetraethyl dithio pyrophosphate, and tetraethyl pyrophosphate, liquid must be packed in specification containers as follows:

(1) Spec. 5, 5A, or 5B. Metal barrels or drums, with openings not exceeding 2.3 inches in diameter.

(2) Spec. 17C or 17E, metal drums (single-trip), with openings not exceeding 2.3 inches in diameter. Spec. 17E drums authorized for not over 5 gallons capacity each.

(3) Spec. 15A or 15B. Wooden boxes, with metal inside containers of not over 5 gallons capacity each.

(4) Spec. 12B. Fiberboard boxes, with inside glass bottles not over 1 gallon capacity each, securely cushioned in liquid-tight metal cans.

(5) Spec. 21B. Fiber drums, with inside glass containers not over 1 gallon capacity each.

(6) Spec. 37A. Metal drums (single-trip), with inside glass containers not over 1 gallon capacity each.

(7) Cylinders as prescribed for any compressed gas, except acetylene, are also authorized.

(8) Spec. 12B. Fiberboard boxes with not more than one inside glass container of not over 1 gallon capacity, securely cushioned. Completed package, with glass container filled with water, when closed for shipment, must be capable of withstanding six four-foot drops onto solid concrete in the order bottom, four sides, and top without breakage.

(9) Spec. 12B. Fiberboard boxes with not more than one inside container of polyethylene, or other nonfragile plastic material, and closed by a screw cap of similar material, not over 16 ounces, surrounded by absorbent cushioning and packed in a one gallon securely closed metal can which shall be surrounded with absorbent cushioning material within the outside fiberboard box.

(10) Spec. 42B. Aluminum drums.

§ 73.359 **Hexaethyl tetraphosphate mixtures, methyl parathion mixtures, parathion mixtures, tetraethyl dithio pyrophosphate mixtures, and tetraethyl pyrophosphate mixtures, liquid.** (a) Hexaethyl tetraphosphate mixtures, methyl parathion mixtures, parathion mixtures, tetraethyl dithio pyrophosphate mixtures, and tetraethyl pyrophosphate mixtures (solutions, emulsions, or emulsifiable liquids) containing not more than 50 percent heaxethyl tetraphosphate, methyl parathion, parathion, tetraethyl dithio pyrophosphate, or tetraethyl pyrophosphate by weight, must be packed in specification containers as follows:

(1) Spec. 5, 5A, or 5B. Metal barrels or drums, with openings not exceeding 2.3 inches in diameter.

(2) Spec. 17C. Metal drums (single-trip), with openings not exceeding 2.3 inches in diameter.

(3) Spec. 17E. Metal drums (single-trip), with openings not exceeding 2.3 inches in diameter. Capacity not to exceed 10 gallons. Authorized only for mixtures not classed as flammable under these regulations.

(4) Spec. 15A, 15B, 15C, or 15E. Wooden boxes, with metal inside containers not over 10 gallons capacity each.

(5) Spec. 12B. Fiberboard boxes, with inside glass bottles not over 1 gallon capacity each, securely cushioned in liquid-tight metal cans.

(6) Spec. 21B. Fiber drums, with inside glass containers not over 1 gallon capacity each.

(7) Spec. 37A. Metal drums (single-trip), with inside glass containers not over 1 gallon capacity each.

(8) Spec. 12B. Fiberboard boxes as authorized by § 78.205-19 (a).

(9) Spec. 12B. Fiberboard boxes with not more than one inside glass container of not over 1 gallon capacity, securely cushioned. Completed package, with glass container filled with water, when closed for shipment, must be capable of withstanding six four-foot drops onto solid concrete in the order bottom, four sides, and top without breakage.

(10) Spec 42B. Aluminum drums.

(b) Hexaethyl tetraphosphate mixtures, methyl parathion mixtures, parathion mixtures, tetraethyl dithio pyrophosphate mixtures, and tetraethyl pyrophosphate mixtures (solutions, emulsions, or emulsifiable liquids containing more than 50 percent hexaethyl, tetraphosphate, methyl parathion, parathion, tetraethyl dithio pyrophosphate, or tetraethyl pyrophosphate by weight, must be packed in specification containers as follows:

(1) Spec. 5, 5A, or 5B. Metal barrels or drums, with openings not exceeding 2.3 inches in diameter.

(2) Spec. 17C Metal drums (single-trip), with openings not exceeding 2.3 inches in diameter.

(3) Spec. 15A or 15B. Wooden boxes, with metal inside containers not over 5 gallons capacity each.

(4) Spec. 12B. Fiberboard boxes, with inside glass bottles not over 1 gallon capacity each, securely cushioned in liquid-tight metal cans.

(5) Spec. 21B. Fiber drums, with inside glass containers not over 1 gallon capacity each.

(6) Spec. 37A. Metal drums (single-trip), with inside glass containers not over 1 gallon capacity each.

(7) Spec. 12B. Fiberboard boxes with not more than one inside glass container of not over 1 gallon capacity securely cushioned. Completed package, with glass container filled with water, when closed for shipment, must be capable of withstanding six four-foot drops into solid concrete in the order bottom, four sides, and top without breakage.

(8) Spec. 42B. Aluminum drums.

(c) Hexaethyl tetraphosphate mixtures, methyl parathion mixtures, parathion mixtures, tetraethyl dithio pyrophosphate mixtures, and tetraethyl pyrophosphate mixtures (solutions, emulsions, or emulsifiable liquids) containing not more than 25 percent hexaethyl tetraphosphate, methyl parathion, parathion, tetraethyl dithio pyrophosphate, or tetraethyl pyrophosphate by weight, in inside metal containers not over 8-fluid ounces capacity each, packed in strong outside containers together with sufficient obsorbent material to completely absorb the liquid in the event of leakage, are exempt from specification packaging, marking, and labeling requirements. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

§ 73.360 **Perchloro-methyl-mercaptan.** (a) Perchloro-methyl-mercaptan in any quantity must not be packed with any other article. When offered for transportation by carriers by rail freight, highway, or water must be packed in specification containers as follows:

(1) Spec. 11A or 11B. Wooden barrels or kegs, with inside containers which must be glass bottles not over 2 quarts capacity each, individually enclosed in tightly closed metal cans and cushioned therein with incombustible material. Net weight not over 100 pounds in one outside container.

(2) Spec. 15A, 15B, 15C, or 16A. Wooden boxes, with inside containers which must be glass bottles not over 2 quarts capacity each, individually enclosed in tightly closed metal cans and cushioned therein with incombustible material. Net weight not over 100 pounds in one outside container.

(3) Spec. 5H. Lead-lined metal barrels or drums not over 33 gallons each.

(4) Spec. 5K or 5M. Nickel or monel barrels or drums.

§ 73.361 **Aldrin mixtures, liquid, with more than 60 percent aldrin.** (a) Aldrin mixtures, liquid, with more than 60 percent aldrin must be shipped in specification containers as follows:

(1) As prescribed in § 73.346.

(2) Spec. 6A, 6B, or 6C. Metal barrels or drums. Authorized only for viscous mixtures or those which may become partially solid.

(3) Spec. 17C or 17H. Metal drums (single-trip). Drums with opening exceeding 2.3 inches in diameter authorized only for viscous mixtures or those which may become partially solid.

(b) Aldrin mixtures, liquid, containing 60 percent or less aldrin and no other material classed as dangerous under these regulations are not subject to Parts 71-78.

§ 73.362 ^{4}Chloro-o-toluidine hydrochloride. (a) ^{4}Chloro-o-toluidine hydrochloride must be shipped in specification containers as follows:

(1) Spec. 12B. Fiberboard boxes with glass, polyethylene, or equally efficient inside containers not over 1 quart capacity each, securely packed in a tightly closed metal container.

(2) Spec. 15A or 15B. Wooden boxes with glass, polyethylene, or equally efficient inside containers not over 1 quart capacity each. Glass containers must be securely packed in tightly closed metal containers.

(3) Spec. 17C or 17H. Metal drums (single-trip).

(4) Spec. 6A, 6B, or 6C. Metal barrels or drums.

§ 73.363 Packing for class B poisons, solid. (a) Closing and cushioning. All containers must be tightly and securely closed. Inside containers must be cushioned as prescribed, or in any case when necessary to prevent breakage or leakage.

(b) Testing inside containers. All inside containers, except those made of glass, must be able to pass a test by dropping, after filling, from a height of 4 feet to solid concrete without rupture or sifting of contents, except that for bags with contents weighing 25 pounds, a drop test of 2 feet is required.

§ 73.364 Exemptions for poisonous solids, class B. (a) Poisonous solids, class B, except beryllium metal powder; cyanides, other than as specified in § 73.370 (b) and (d); hexaethyl tetraphosphate mixtures, methyl parathion mixtures, parathion mixtures, tetraethyl dithio pyrophosphate mixtures, and tetraethyl pyrophosphate mixtures, other than as specified in § 73.377 (e); in tightly closed inside containers, securely cushioned when necessary to prevent breakage and packed as follows, are exempt from specification packaging, marking, and labeling requirements, except that marking name of contents on outside container is required for shipments via carrier by water. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

(1) In inside glass, earthenware, or composition bottles or jars, or metal containers, or lock-corner sliding-lid wooden boxes, of not over 5 pounds capacity each, except carbolic acid (phenol) in glass containers must not exceed 1 pound capacity each; or chipboard, pasteboard, or fiber cartons, cans, or boxes, of not over 1 pound capacity each, packed in outside wooden or fiberboard boxes, or wooden barrels or kegs. Net weight of contents of outside container not over 100 pounds.

(2) In inside chipboard, pasteboard, or fiber cartons, cans, or boxes, of not over 5 pounds capacity each, packed in outside fiberboard or wooden boxes. Not more than 6 of these cartons shall be packed in any outside container.

§ 73.365 Poisonous solids not specifically provided for. (a) Poisonous solids, as defined in § 73.343, other than those for which special requirements are prescribed, must be packed in specification containers of a design and constructed of materials that will not react dangerously with or be decomposed by the chemical packed therein, as follows:

(1) Spec. 5, 5A, 5B, 6A, 6B, or 6C. Metal barrels or drums.

(2) Spec. 17H, 37A, or 37B. Metal drums (single-trip). Gross weight not over 375 pounds, except for materials fused solid in the drum a gross weight of 880 pounds is authorized in drums constructed of at least 18 gauge steel regardless of gross weight marking embossed in the container.

(4) Spec. 10A, 10B, or 10C. Wooden barrels or kegs lined with creped-paper bag, spec. 2J. Liner may be omitted if material is not pulverized or liable to sift.

NOTE 1: Because of the present emergency and until further order of the Commission, wooden whiskey barrels, with char removed and properly recoopered, which comply with all the provisions of spec. 10B, are also authorized. Marking is required on the head of each container, by the reconditioner, by hot branding iron, as follows:

ICC-10B.

Name or symbol (letters) of reconditioner; this must be registered with the Bureau of Explosives and located just above, below, or following the mark ICC-10B.

Size of markings (minimum): ¾-inch high.

(5) Spec. 11A. Wooden barrels or kegs, tongued and grooved, net weight of contents not over 115 pounds each.

(6) Spec. 12B or 12C. Fiberboard boxes, with inside containers which must be metal cans not over 25 pounds capacity each; glass bottles not over 1 gallon capacity each; fiber cans or boxes, spec. 2G; sliding-top wooden boxes, lined to prevent sifting, not over 25 pounds capacity each; or paper bags, spec. 2D. Packages containing glass or earthenware containers must not weigh over 65 pounds gross nor contain more than 4 inside containers of over 5 pints capacity each. Outside containers must be not over 5,000 cubic inches capacity nor contain over 50 pounds net weight each, except as provided in § 78.205-23.

TEST: The complete package prepared as for shipping must be capable of standing a drop of 4 feet to solid concrete without breakage of the container or any sifting of contents.

(7) Spec. 12B. Fiberboard boxes with securely closed inside fiberboard or chipboard boxes not over 6 pounds net weight each. Interior containers must be at least 0.28 inches thick for those not over 2½ pounds net weight each and at least 034 inches thick for others. Outside packages must contain not over 36 pounds net weight of material each.

TEST: The individual interior containers as well as the completed package prepared as for shipping must be capable of standing a drop of 4 feet to solid concrete without breakage of the container or any sifting of contents.

(8) Spec. 15A. Wooden boxes, with inside containers which must be securely closed paper bags, placed within a waterproof duplex bag, spec. 2J. Net weight of material in one outside box, not over 100 pounds.

(9) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes, with inside containers which must be metal cans not over 25 pounds capacity each; glass or earthenware containers not over 1 gallon capacity each; except that inside containers of not over 5 gallons each and containing not over 25 pounds net weight are authorized when only one inside container is packed in each outside container. Fiber cans or boxes, spec. 2G, or sliding-top wooden boxes, lined to prevent sifting, not over 25 pounds capacity each. Net weight of material in outside container, not over 100 pounds each.

(10) Spec. 18B. Wooden kits lined as prescribed by spec. 2K. Net weight not over 30 pounds each.

(11) Spec. 21A. Fiber drums. Net weight not over 115 pounds each.

NOTE 1: Because of the present emergency and until further order of the Commission, use is permitted of spec. 21A fiber drums, that will withstand two drops from height of 4 feet in same spot or one 6-foot drop, in place of drop test as provided in specification 21A. Maximum loaded capacity 225 pounds net.

(12) Spec. 22A. Plywood drums. Net weight not over 115 pounds each.

(13) Spec. 103, 103W, 103A, or 103A-W. Tank cars.

(14) Spec. 21B. Fiber drums.

§ 73.366 **Arsenic (arsenic trioxide) or arsenic acid (solid).** (a) Arsenic (arsenic trioxide) or arsenic acid (solid) must be packed in specification containers as follows:

(1) As prescribed in § 73.365 of this part.

(2) Spec. 10A, 10B, or 10C. Wooden barrels or kegs with tongued-and-grooved staves; a 4½-inch metal bung in the head is permitted; lining not required.

(b) Import shipments of arsenic (arsenic trioxide) may also be shipped when packed as follows:

(1) Inclosed in strong waterproofed cloth containers, securely sewn and closed so as to provide a sift-proof package, and then packed in strong, tight, metal-strapped wooden boxes constructed of material not less than three-fourths inch thick throughout.

(2) In strong and tight metal drums inclosed in a strong outside wooden barrel.

§ 73.367 **Arsenical compounds n.o.s., arsenate of lead, calcium arsenate, Paris green, and arsenical mixtures.** (a) Arsenical compounds n.o.s., arsenate of lead, calcium arsenate, Paris green, and arsenical mixtures must be packed in specification containers as follows:

(1) As prescribed in § 73.365 of this part.

NOTE 1: Because of the present emergency and until further order of the Commission, wooden hoops as specified in § 78.160-6 may be used in lieu of steel hoops required by specification 10B.

(2) Spec. 36A or 36B. Triplex bags. Authorized only for arsenical insecticides and fungicides containing 10.0 percent or less of arsenic trioxide.

(3) Spec. 44B. Multiwall paper bags with inside paper bags, spec. 2D. Net weight not over 50 pounds each.

(4) Spec. 44C. Multiwall paper bags. For carload and truckload shipments only. Net weight not over 50 pounds each.

(5) Spec. 44D. Multiwall paper bags. For less-than-carload and less-than-truckload shipments. Net weight not over 50 pounds each.

(b) Arsenical compounds n. o. s. containing not more than 6 percent arsenic of which not more than 0.5 percent is water soluble must be packed in specification containers as follows:

(1) As prescribed in paragraph (a) (1), (2), or (3) of this section.

(2) Spec. 44B. Paper bags with two added inside thicknesses of No. 1 Kraft paper, one sheet having a Mullen test of 50 and the other sheet having a Mullen test of 40. Net weight not over 50 pounds each.

§ 73.368 **Arsenical dust, arsenical flue dust, and other poisonous noncombustible by-product dusts.** (a) Arsenical dust, arsenical flue dust, and other poisonous noncombustible by-product dusts from metal recovery operations not subject to dangerous spontaneous heating, and arsenic trioxide, or sodium arsenate, when delivery is made to plants with private sidings, only, may, in addition to containers prescribed in §73.367 of this part, be shipped in sift-proof, self-clearing, hopper or bottom outlet steel cars or in sift-proof all steel flat bottom gondola cars with fixed sides and ends equipped with water-proof and dustproof wooden or steel covers well secured in place for all openings, or in sift-proof box cars of all steel construction only when said cars are assigned exclusively to this service. See § 74.566 (b) for cleaning cars. Such cars, when exclusively in this service, are not subject to the requirements of § 74.566 (b).

(b) Arsenical dust and arsenic trioxide may be shipped in bulk in motor vehicles with steel, sift-proof, self-clearing hopper-type or dump-type bodies, with waterproof and dust-proof covers, well secured in place.

§ 73.369 **Carbolic acid (phenol), not liquid.** (a) Carbolic acid (phenol), not liquid, must be packed in specification containers as follows:

(1) Spec. 5, 5A, 5B, 5C, 6A, 6B, or 6C. Metal barrels or drums.

(2) Spec. 11A or 11B. Wooden barrels or kegs with securely closed inside drums of metal not thinner than No. 26 gauge, the space between drum and barrel or keg being filled with sawdust or rice hulls

(3) Spec. 11A or 11B. Wooden barrels or kegs with glass or earthenware inside containers, not over 1 gallon capacity each, or with metal inside containers not over 2 gallons capacity each.

(4) Spec. 12B. Fiberboard boxes with inside containers which must be metal cans not over 25 pounds capacity each.

(5) Spec. 12B. Fiberboard boxes with glass or earthenware inside containers not over 1 quart capacity each, or with metal inside containers not over 1 gallon capacity each. Packages containing glass or earthenware containers must not weigh over 65 pounds gross; packages containing metal cans not over 84 pounds gross as provided in § 78.205-23, 65 pounds for others.

(6) Spec 12D. Fiberboard boxes with inside containers which must be: Glass or earthenware not over 1 gallon or 5 pounds capacity each; authorized for not more than 75 pounds gross weight; not to contain more than 4 such inside containers if their capacity is greater than 5 pints each.

(7) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with glass or earthenware inside containers not over 1 gallon or 5 pounds capacity each, except that inside containers up to 3 gallons or 15 pounds capacity each are authorized when only 1 is packed in each outside container; or with metal inside containers not over 10 gallons capacity each.

(8) Spec. 15A, 15B, or 15C. Wooden boxes with metal inside containers, Spec. 2F not over 250 pounds total capacity each.

(9) Spec. 17E or 17H. Metal drums (single-trip).

(11) Spec. 37A or 37B. Metal drums (single-trip).

(12) Spec. 42B or 42C. Aluminum drums.

(13) Spec. 103, 103W, 103AL-W, 103A, 103A-W or 103A-AL-W. Tank cars.

(14) Spec. MC 300, MC 301, MC 302, or MC 303. Tank motor vehicles.

§ 73.370 **Cyanides, or cyanide mixtures, except cyanide of calcium and mixtures thereof.** (a) Cyanides, or cyanide mixtures (see par. (b) of this section for exemptions), except cyanide of calcium and mixtures thereof (see par. (c) of this section for packing requirements and par. (d) of this section for exemptions) if containing the cyanogen equivalent of 10 percent or more of potassium cyanide, must be packed in specification containers as follows:

(1) Spec. 15A, 15B, or 15C. Wooden boxes with metal inside containers, spec. 2F, not over 25 pounds capacity each; or hermetically sealed (soldered) metal lining, spec. 2F, or in glass bottles not over 5 pounds capacity each.

(2) Spec. 11A or 11B. Wooden barrels with metal inside containers, spec. 2F not over 25 pounds capacity each; or hermetically sealed (soldered), metal lining, spec. 2F.

(3) Spec. 12B or 12C Fiberboard boxes with metal inside containers, spec. 2F not over 25 pounds capacity each.

(4) Spec. 5, 5A, 5B, 6A, 6B, or 6C. Metal barrels or drums.

(5) Spec. 37A or 37B. Metal drums (single-trip containers).

(6) Bulk in watertight metal cars or in watertight container or metal containers.

(8) Spec. 45B. Bags, cloth and paper, lined. Authorized only for sodium cyanides of globular or pellet form, diameter not less than ¾ inch Net weight not over 100 pounds.

(9) Bulk in watertight metal-bodied covered motor vehicles.

(10) Spec. 21A. Fiber drums which must be lined or coated, or otherwise treated so as to prevent the entrance of moisture in quantities sufficient to create a hazardous condition in transportation; drums to withstand two drops from height of 4 feet in same spot or one 6-foot drop, in place or drop test as provided in spec. 21A; maximum loaded capacity 225 pounds net. Use of this container will be permitted because of the present emergency and until further order of the Commission.

(11) Spec. 21B. Fiber drums.

(b) Cyanides, except cyanide of calcium and mixtures thereof; exemptions. Cyanides, except cyanide of calcium and mixtures thereof (see paragraph (d) of this section), when packed and described as follows are exempt from specification packaging and labeling requirements. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I C.C. Motor Carrier Safety Regulations.

(1) Cyanide, or cyanide mixtures, in tightly closed glass earthenware, or metal inside containers, not over 1 pound each, securely cushioned and packed in outside wooden or fiberboard boxes, or in wooden barrels. Net weight of cyanides or cyanide mixtures in any outside container, not over 25 pounds.

(2) Cyanide mixtures in tightly closed glass, earthenware, or metal inside containers, securely cushioned and packed in outside wooden or fiberboard boxes, or in wooden barrels. Net weight of cyanide mixtures in any outside container, not over 5 pounds.

(3) Cyanides of copper, zinc, lead and silver.

(c) Cyanide of calcium and mixtures thereof. Cyanide of calicum and mixtures thereof must be packed in specification containers as follows:

(1) As prescribed in paragraphs (a) (2), (3), (4), (6), (8), (9), (10) or (11) of this section.

(2) Spec. 15A, 15B, or 15C. Wooden boxes with metal inside containers, spec. 2F, not over 25 pounds capacity each; or hermetically sealed (soldered) metal lining, spec. 2F.

(3) Spec. 37A or 37B. Metal drums (single-trip containers); welded side seams required for Spec. 37B drums and all seams and closures must be watertight and hermetically sealed.

(d) Cyanide of calcium and mixtures thereof; exemptions. Cyanide of calicum and mixtures thereof when packed and described as follows are exempt from specification packaging and labeling requirements. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

(1) Cyanide of calcium and mixtures thereof in tightly closed metal inside containers, not over 1 pound each, securely cushioned and packed in outside wooden or fiberboard boxes, or in wooden barrels. Net weight of cyanide of calcium or mixtures thereof in any outside container, not over 25 pounds.

(2) Cyanide of calcium or mixtures thereof in tightly closed metal inside containers, securely cushioned and packed in outside wooden or fiberboard boxes, or in wooden barrels. Net weight of cyanide of calcium or mixtures thereof in any outside container, not over 5 pounds.

§ 73.371 **Dinitrobenzol.** (a) Dinitrobenzol must be packed in specification containers as follows:

(1) As prescribed in § 73.346 or §73.365.

(2) Spec. 11A. Wooden barrels, gross weight 300 pounds; must be shipped in carload or truckload shipments only and must not be offered for transportation by carriers by rail express or water.

§ 73.372 **Mercury bichloride.** (a) Mercury bichloride must be packed in specification containers as follows:

(1) As prescribed in § 73.365 of this part.

(2) Spec. 15A. Wooden boxes with inside containers consisting of strong paper bags in tightly closed inside wooden boxes.

§ 73.373 **Paranitraniline.** (a) Paranitraniline must be packed in specification containers as follows:

(1) As prescribed in §73.365 of this part.

(2) Spec. 11A. Wooden barrels, gross weight 385 pounds; must be shipped in carload or truckload shipments only, and must not be offered for transportation by carriers by rail express or water.

(3) Spec. 21A or 21B. Fiber drums, gross weight 400 pounds; side walls must be of at least 10-ply construction having strength not less than 1,200 pounds Mullen or Cady test; drums must withstand prescribed tests when filled to authorized gross weight of 400 pounds.

§ 73.374 **Nitrochlorbenzene, meta or para.** (a) Nitrochlorbenzene, meta or para, must be packed in specification containers as follows:

(1) As prescribed in § 73 365 of this part.

(2) Spec. 21A or 21B. Fiber drums, authorized only for nitrochlorbenzene, para, flaked, gross weight 400 pounds; side walls must be of at least 10-ply construction having strength not less than 1,200 pounds Mullen or Cady test; drums must withstand prescribed tests when filled to authorized gross weight of 400 pounds.

§ 73.375 **Sodium azide.** (a) Sodium azide must be packed in specification containers as follows:

(1) Spec. 15A. Wooden boxes, with inside containers which must be securely closed paper bags, placed within a waterproof duplex bag, spec. 2J. Net weight of material in one outside box, not over 100 pounds.

NOTE 1: Because of the present emergency and until further order of the Commission, uncreped bags may be used.

§ 73.376 **Aldrin mixtures, dry, with more than 65 percent aldrin.** (a) Aldrin mixtures, dry, with more than 65 percent aldrin, must be packed in specification containers as follows:

(1) As prescribed in § 73.365.

(b) Dry mixtures containing 65 percent or less aldrin, or aldrin, cast solid, and containing no other material classed as dangerous under these regulations are not subject to Parts 71-78.

§73.377 **Hexaethyl tetraphosphate mixtures, methyl parathion mixtures, parathion mixtures, tetraethyl dithio pyrophosphate mixtures, and tetraethyl pyrophosphate mixtures, dry.** (a) Hexaethyl tetraphosphate mixtures, methyl parathion mixtures, parathion mixtures, tetraethyl dithio pyrophosphate mixtures, and tetraethyl pyrophosphate mixtures in which the liquid is absorbed in concentrations greater than 2 percent but not exceeding 27 percent in an inert dry material so as to form a dry mixture, must be packed in specification containers as follows:

(1) Spec. 12B or 12C, fiberboard boxes, with inside containers which must be metal or fiber cans not over 12 pounds capacity each, or paper bags, spec. 2D, not over 12 pounds capacity each. Inside containers and the completed package must be capable of withstanding the tests prescribed in paragraphs (c), (d), and (e) of this section.

(2) Spec. 15A, or 15B. Wooden boxes, with inside containers which must be metal or fiber cans not over 12 pounds capacity each, or paper bags, spec. 2D, not over 12 pounds capacity each. Inside containers must be capable of withstanding the tests prescribed in paragraphs (c) and (d) of this section.

(3) Spec. 5, 5B, 6A or 6C, metal barrels or drums.

(4) Spec. 17C, 17H or 37A, metal drums (single-trip). Spec. 37A metal drums authorized for not over 100 pounds net weight.

(5) Spec. 21A or 21B, fiber drums.

(b) Hexaethyl tetraphosphate mixtures, methyl parathion mixtures, parathion mixtures, tetraethyl dithio pyrophosphate mixtures, and tetraethyl pyrophosphate mixtures in which the liquid is absorbed in concentrations greater than 27 percent in an inert dry material so as to form a dry mixture, must be packed in specification containers as follows:

(1) Spec. 12B or 12C, fiberboard boxes, with inside containers which must be metal cans not over 12 pounds capacity each. Inside containers and the completed package must be capable of withstanding the tests prescribed in paragraphs (c), (d), and (e) of this section.

(2) Spec. 15A or 15B, wooden boxes, with inside containers which must be metal cans not over 12 pounds capacity each. Inside containers must be capable of withstanding the tests prescribed in paragraphs (c) and (d) of this section.

(3) Spec. 5, 5B, 6A, or 6C, metal barrels or drums.

(4) Spec 17C, 17H, or 37A, metal drums (single-trip). Spec. 37A metal drums authorized for not over 100 pounds net weight.

(c) Inside metal or fiber cans when closed as for shipment must be capable of withstanding two four-foot drops onto solid concrete without breakage of the container or any sifting of the contents. One drop must be on side of can and the other diagonally on the top rim or chime.

(d) Inside paper bags when closed as for shipment must be capable of withstanding two four-foot drops onto solid concrete without breakage of the container or any sifting of the contents. One drop must be made on bottom of bag and the other on either large face.

(e) Completed packages when closed as for shipment must be capable of withstanding two four-foot drops onto solid concrete without breakage of the container or any sifting of the contents. One drop must be made on bottom of package and the other drop on the smallest adjament side area.

(f) Dry mixtures containing not more than 2 percent by weight of hexaethyl tetraphosphate, methyl parathion, parathion, tetraethyl dithio pyrophosphate, or tetraethyl pyrophosphate, and in which the liqjuid is absorbed in an inert material, are exempt from specification packaging, marking, and labeling requirements. Shipments for transportation by highway carriers are exempt also from Part 77, except § 77.817, and Part 197.

(g) Dry mixtures containing more than 2 percent but not exceeding 15 percent by weight of hexaethyl tetraphosphate, methyl parthion, parathion, tetraethyl dithio pyrophosphate, or tetraethyl pyrophosphate, and in which the liquid is absorbed in an inert material, in addition to containers prescribed in paragraphs (a) and (b) of this section, may be packed in specification containers as follows:

(1) Spec. 44B. Multi-wall paper bags with inside paper bags, spec. 2D, not over 5 pounds capacity each. Net weight of material in outside container not over 30 pounds each.

(h) Dry mixtures containing more than 2 percent but not exceeding 5 percent by weight of hexaethyl tetraphosphate, methyl parathion, parathion, tetraethyl dithio pyrophosphate, or tetraethyl pyrophosphate, and in which the liquid is absorbed in an inert material, in addition to containers prescribed in paragraphs (a), (b), and (g) of this section, may be packed in specification containers as follows:

(1) Spec. 44D. Multi-wall paper bags not over 50 pounds net weight each.

§ 73.378 **Beryllium metal powder.** (a) Beryllium metal powder must be packed in specification containers as follows:

(1) Spec. 5, 5A, 5B, 6A, 6B or 6C. Metal barrels or drums.

(2) Spec. 17H, 37A, or 37B. Metal drums (single-trip).

(3) Spec. 15A, 15B, 15C, 16A, or 19A. Wooden boxes with inside metal cans not over 25 pounds capacity each.

(4) Spec. 12B or 12C. Fiberboard boxes with inside metal cans not over 25 pounds capacity each.

(5) Spec. 21A or 21B. Fiber drums, with inside glass or metal containers of not over 25 pounds capacity each.

§ 73.381 **Tear gas or irritating substances class C, Tear Gas Label; definition.** (a) For the purpose of Parts 71-78 tear gases are liquid or solid substances which upon contact with fire or when exposed to air give off dangerous or intensely irritating fumes, such as brombenzylcyanide, chloracetophenone, diphenylaminechlorarsine, and diphenylchlorasine, but not including any poisonous article, class A.

(b) All containers must be tightly and securely closed. Inside containers must be cushioned as prescribed, or in any case when necessary to present breakage or leakage.

(c) It shall not be permissible to transport class C poisons if there be any interconnecting means of any character between the containers.

§ 73.382 **Tear gas or irritating substances, class C, not specifically provided for.** (a) Tear gas or irritating substances, class C, as defined in § 73.381 (a) of this part for which special packing is not prescribed, must be packed in specification containers as follows:

(1) Spec. 5, 5A, or 5B, metal barrels or drums; or spec. 17C, metal drums (single-trip) not over 5 gallons capacity each.

(2) Spec. 6A, 6B, or 6C. Metal barrels or drums.

(3) Spec. 15A or 15B. Wooden boxes with inside metal containers of not over 1 liquid gallon (10 pounds) capacity each. Not over 8 liquid gallons (80 pounds) of material may be packed in any outside container.

(4) Cylinders as prescribed for any compressed gas, except acetylene, are also authorized for use. These cylinders must be qualified, maintained, and filled in accordance with §§73.34 and 73.301 (g) of this part, if used for material with pressure exceeding 25 pounds per square inch at 70° F., they must also be retested as required by § 73.34 of this part.

(b) No class C poisons in cargo tanks. No "tear gases or irritating substances, class C" may be loaded into or transported in any cargo tank.

§ 73.383 **Chemical ammunition.** (a) Chemical ammunition consisting of projectiles, shells, bombs, and other containers, except grenades, filled with gases, liquids, or chemicals class C without ignition elements, bursting charges, detonating fuzes, or other explosive components, must be packed for shipment in strong outside wooden or metal boxes. Boxes must be marked with name of contents and labeled as prescribed by this part for the gases, liquids, or chemicals contained therein.

(b) Chemical ammunition, when shipped as such, must not be equipped or packed with explosive or ignition elements (see §§73.53 (r) and 73.59 of this part for explosive chemical ammunition).

§ 73.384 **Monochloracetone, stabilized.** (a) Monochloracetone, stabilized, must be packed in specification containers as follows:

(1) Spec. 5, 5A, or 17C. Metal barrels or drums not over 5 gallons capacity each.

(2) Spec 15A, 15B, 15C, or 16A. Wooden boxes with inside glass bottles or tubes in hermetically sealed metal cans in corrugated fiberboard cartons, spec. 2C. Bottles must contain not over 1 pound of liquid each, must be filled to not over 95 percent capacity, must be tightly and securely closed, and must be cushioned in cans with at least ½ inch of absorbent material. Cans must be made of metal at least 32 gauge United States standard. Total amount of liquid in outside box must not exceed 24 pounds.

§ 73.385 **Tear gas grenades, tear gas candles, or similar devices.** (a) Tear gas grenades, tear gas candles, or similar devices containing lachrymatory (tear producing) substances, for civil or military use must be packed in specification containers as follows (see § 73.101 (d) and (e) of this part for packing tear gas cartridges):

(1) Spec. 15A, 15B, or 15C. Metal-strapped wooden boxes. Functioning elements not assembled in grenades or devices must be in a separate compartment of these boxes, or in inside or separate outside boxes, spec 15A, 15B, or 15C, and must be so packed and cushioned that they may not come in contact with each other or with the walls of boxes during transportation. Not more than 24 grenades and 24 functioning devices shall be packed in one outside container and the gross weight of the package must not exceed 75 pounds.

(2) Spec. 37A Metal drum (single-trip). Functioning elements must be packed in separate compartment. Not more than 24 grenades and 24 functioning devices shall be packed in one outside container and the gross weight of the container must not exceed 75 pounds.

(b) These articles must not be assembled with or packed in the same compartment with mechanically or manually operated firing, igniting, bursting, or other functioning elements, unless of a type or design approved by the Bureau of Explosives.

(c) Pending approval by the Commission of regulations classifying the numerous devices within the general descriptions of this section, and providing appropriate restrictions to be observed in the transportation thereof, no shipment of packages containing articles under this section shall be made until samples thereof have been examined by the Bureau of Explosives or by other competent testing laboratory in the presence of representative of the Bureau of Explosives, and the shipment is shown to possess such resistance to shocks of transportation and protection against leakage of contents as are afforded by standard types of packages described in Part 78, and the packages are labeled or marked to show compliance with this part.

NOTE 1: Grenades or other similar devices may be shipped completely assembled when shipments are made by, for, or to the Departments of the Army, Navy, and Air Force of the United States Government, provided the functioning element is so packed that it cannot accidentally function. The outside containers must be metal-strapped wooden boxes, spec. 15A, 15B, or 15C.

§ 73.391 **Radioactive materials class D Poison; definition.** (a) For the purpose of Parts 71-78 radioactive material is any material or combination of materials that spontaneously emits ionizing radiation. For the purpose of Parts 71-78, radioactive materials are divided into three groups according to the type of rays emitted at any time during transportation, as follows:

(1) Group I. Radioactive materials that emit gamma rays only or both gamma and electrically charged corpuscular rays.

(2) Group II. Radioactive materials that emit neutrons and either or both the types of radiation characteristic of Group I materials

(3) Group III. Radioactive materials that emit electrically charged corpuscular rays only, i.e., alpha or beta, etc., or any other that is so shielded that the gamma radiation at the surface of the package does not exceed 10 milliroentgens for 24 hours at any time during transportation.

(b) Not more than 2,000 millicuries of radium, polonium, or other members of the radium family of elements, and not more than 2,700 millicuries (disintegration rate of 100,000 million (10^{11}) atoms per second) of any other radioactive substance may be packed in one outside container for shipment by rail freight, rail express, or highway, except by special arrangements and under conditions approved by the Bureau of Explosives or except as specifically provided in subparagraph (c) of this section.

NOTE 1: For purposes of Parts 71-78 one millicurie is that amount of any radioactive material which disintegrates at the rate of 37 million atoms per second. One thousand millicuries is equal to one curie.

(c) Not more than 300 curies of solid cesium 137, cobalt 60, gold 198, or iridium 192 may be packed in one outside container for shipment by rail freight, rail express, or highway, except by special arrangements and under conditions approved by the Bureau of Explosives.

§ 73.392 **Exemptions for radioactive materials.** (a) Radioactive materials are exempt from prescribed packaging, marking, and labeling requirements provided they fulfill all of the conditions in subparagraphs (a) (1), (2), and (3). Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

(1) The package must be such that there can be no leakage of radioactive material under conditions normally incident to transportation.

(2) The package must contain not more than 0.1 millicuries of radium, or polonium, or that amount of strontium 89, strontium 90, or barium 140 which disintegrates at a rate of more than 5 million atoms per second; or that amount of any other radioactive substance which disintegrates at a rate of more than 50 million atoms per second.

(3) The package must be such that no significant alpha, beta, or neutron radiation is emitted from the exterior of the package and the gamma radiation at any surface of the package must be less than 10 milliroentgens for 24 hours.

(b) Manufactured articles other than liquids, such as instrument or clock dials or electronic tubes and apparatus, of which radioactive materials are a component part, and luminous compounds, when securely packed in strong outside containers are exempt from specification packaging, marking, and labeling requirements provided the gamma radiation at any surface of the package is less than 10 milliroentgens in 24 hours. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

(1) Switchboard or similar apparatus containing electronic tubes, of which radioactive materials are a component part, are exempt from specification packaging, marking, and labeling requirements when shipped in carload or truckload lots or when transported by private motor carrier provided the gamma radiation at any readily accessible surface of the units when prepared for shipment does not exceed 50 milliroentgens in 24 hours. Shipments for transportation by highway carriers are exempt also from Part 77, except section 77.817 of these regulations, and Part 197 of the I.C.C. Motor Carrier Safety Regulations.

(c) Radioactive materials such as ores, residues, etc., of low activity packed in strong tight containers are exempt from specification packaging and labeling requirements for shipment in carload lots by rail freight only provided the gamma radiation or equivalent will not exceed 10 milliroentgens per hour at a distance of 12 feet from any surface of the car and that the gamma radiation or equivalent will not exceed 10 milliroentgens per hour at a distance of 5 feet from either end surface of the car. There must be no loose radioactive material in the car and the shipment must be braced so as to prevent leakage or shift of the lading under conditions normally incident to transportation. The car must be placarded by the shipper as provided in §§ 74.541 (b) and 74.553. Except when handling is supervised by the Atomic Energy Commission, shipments must be loaded by consignor and unloaded by consignee.

(d) Detonating fuzes with radioactive components as described in § 73.53 (g) (2) are exempt from labeling requirements.

§ 73.393 **Packing and shielding.** (a) Radioactive materials that present special hazards due to their tendency to remain fixed in the human body for long periods of time (i. e., radium, plutonium, and radioactive strontium, etc.) must, in addition to the packing hereinafter prescribed, be packed in inside metal containers specification 2R, or other container approved by the Bureau of Explosives.

(b) All radioactive materials must be so packed and shielded that the degree of fogging of undeveloped film under conditions normally incident to transportation (24 hours at 15 feet from the package) will not exceed that produced by 11.5 milliroentgens of penetrating gamma rays of radium filtered by ½ inch of lead.

(c) The design and preparation of the package must be such that there will be no significant radioactive surface contamination of any part of the container.

(d) The smallest dimension of any outside shipping container for radioactive materials must be not less than 4 inches.

(e) All outside shipping containers must be of such design that the gamma radiation will not exceed 200 milliroentgens per hour or equivalent at any point of readily accessible surface. Containers must be equipped with handles and protective devices when necssary in order to satisfy this requirement.

(f) The outside shipping container for any radioactive material, unless specifically exempt by § 73.392 or unless approved by the Bureau of Explosives, shall be as follows:

(1) Spec. 15A or 15B. Wooden boxes Authorized for not more than 2,700 millicuries.

(2) Spec. 12B. Fiberboard boxes. Authorized for not more than 2,700 millicuries.

(3) Spec. 21A or 21B. Fiber drums. Authorized for not more than 2,700 millicuries

(4) Spec. 6A, 6B, or 6C; 17C or 17H (single-trip). Metal barrels or drums. Authorized for not more than 2,700 millicuries.

(5) Spec. 55, metal-encased, lead or uranium metal-shielded containers. Authorized for not more than 300 curies (see § 73.391). Containers must be equipped with a seal.

(g) Radioactive materials Group I, liquid, solid, or gaseous, must be packed in suitable inside containers completely surrounded by a shield of lead or other suitable material of such thickness that at any time during transportation the gamma radiation at one meter (39.3 inches) from any point on the radioactive source will not exceed 10 milliroentgens per hour. The shield must be so designed that it will not open or break under conditions incident to transportation. The minimum shielding must be sufficient to prevent the escape of any primary corpuscular radiation to the exterior of the outside shipping container.

(h) Radioactive materials Group II, liquid, solid, or gaseous, must be packed in suitable inside containers completely shielded so that at any time during transportation the radiation measured at right angles to any point on the long axis of the shipping container will not exceed the limits specified in subparagraphs (1) to (4) of this paragraph. The shielding must be designed so as to maintain its efficiency under conditions normally incident to transportation and must provide personnel protection against fast or slow neutrons and all other ionizing radiation originating in the radioactive materials or any part of the aggregate constituting the complete package

(1) Gamma radiation of 10 mrhm.

(2) Electrically charged corpuscular radiation which is the physical equivalent (see note 1 of this paragraph) of 10 mrhm, of gamma radiation.

(3) Neutron radiation which is the physical equivalent (see Note 1 of this paragraph) of 2 mrhm, of gamma radiation.

(4) If more than one of the types of radiation named in subparagraphs (1), (2), and/or (3) of this paragraph is present the radiation of each type must be reduced by shielding so that the total does not exceed the equivalent of subparagraphs (1), (2), or (3) of this paragraph.

NOTE 1: For purposes of Parts 71-78 the "physical equivalent" of a roentgen is that amount of radiation that would be absorbed in tissue to the extent of approximately 100 ergs per gram (mrhm. is an abbreviation for milliroentgens per hour at 1 meter (39.3 inches)).

(i) Liquid radioactive materials Groups I, II or III must, in addition, be packed in tight glass, earthenware or other suitable inside containers. The inside containers must be surrounded on all sides by an absorbent material sufficient to absorb the entire liquid contents and of such nature that its efficiency will not be impaired by chemical reaction with the contents. Where use of shielding is necessary to reduce radiation to limits prescribed by this section, the absorbent cushioning material must be placed within the shield. If the container is packed in a metal container specification 2R or other container approved by the Bureau of Explosives, the absorbent cushioning is not required.

(j) Radioactive materials Group III, liquid, solid or gaseous, must be packed in suitable inside containers completely wrapped and/or shielded with such material as will prevent the escape of primary corpuscular radiation to the exterior of the shipping container, and secondary radiation at the surface of the container must not exceed 10 milliroentgens per 24 hours, at any time during transportation.

(k) In determining compliance with requirements of paragraphs (e), (g), (h), and (j) of this section measurements of radiation must be made with a Landsverk-Wollan Electrometer Model L-100 or equally efficient standardized meter.

§ 73.394 **Radioactive materials labels.** (a) Each outside container of radioactive material Group I or II, unless exempt by § 73.392 of this part, must be labeled with a properly executed label as described in § 73.414 (a) of this part.

(b) Each outside container of radioactive material Group III must be exempt by § 73.392 of this part, be labeled with a properly executed label as described in § 73.414 (b) of this part.

§ 73.395 **Cleaning cars and vehicles.** (a) Any box car or motor vehicle which, after use for the transportation of radioactive materials in carload or truckload lots, is contaminated with such materials to the extent that a survey of the interior surface shows that the beta-gamma radiation is greater than 10 milliroentgens physical equivalent in 24 hours or that the average alpha contamination is greater than 500 disintegrations per minute per 100 square centimeters shall be thoroughly cleaned in such a manner that a resurvey of the interior surface shows the contamination be below these levels. A certificate to that effect must be furnished to the local agent of the carrier or to the driver of the motor vehicle. Cars and motor vehicles which are used solely for the transportation of radioactive materials are exempt from the provisions of this section.

§ 73.396 **Radioactive materials handling.** (a) When radioactive materials are loaded into railroad cars or motor vehicles by the shipper, the shipper shall observe all applicable requirements of § 75.655 (j) or § 77.841 (d), as the case may be.

SUBPART H — MARKING AND LABELING EXPLOSIVES AND OTHER DANGEROUS ARTICLES

NOTE: The markings prescribed for containers should be as near together as possible.

§ 73.400 **Explosives.** (a) Each package containing explosives must be marked with its proper shipping name as shown in § 72.5 and such other marking as prescribed for the explosive in the shipment. Abbreviations must not be used. (See Note 1.)

NOTE 1: In descriptions of ammunition, such as ammunition for cannon without projectiles, etc., the words with or without may be abbreviated as W or W/O, i. e., Ammunition for cannon W/O projectiles.

(b) Packages containing explosives must show on top the marking "THIS SIDE UP" when required by § 73.60 (e) (1) and §§ 73.63 (f) and 73.65 (i) of this part.

(c) Each package of explosives must show the name and address of the consignee except in carloads and truckloads or less-than-truckloads when handled by a motor vehicle not requiring transfer from one motor carrier to another. When offered for transportation by carrier by water each package must show the name or mark of the consignor and/or consignee.

(d) Each package of chemical ammunition, explosive, containing poisonous gases, solids or liquids, class A, class B or class C must also have securely attached to it labels prescribed by § 73.409 (a) (1), (a) (2), or (a) (3) of this part.

(1) Carload or truckload shipments of chemical ammunition, explosive, containing poisonous gases, solids or liquids, class A, class B, or class C offered for transportation by, for, or to the Departments of the Army, Navy, and Air Force of the United States Government are exempt from labeling requirements when shipments are loaded or unloaded by the shipper or his duly authorized agent and such shipments are accompanied by qualified personnel supplied with equipment to repair leaks or other container failure which will permit escape of contents.

(e) Each shipment of samples of explosives when offered for transportation by carriers by rail express or water must bear the label prescribed by § 73.411 of this part and each shipment of special fireworks in addition to the marking prescribed by § 73.91 (i) of this part when offered for transportation by carriers by rail express or water must bear the label prescribed by § 73.410 of this part.

(f) Each shipment of propellant explosives when offered for transportation by carriers by rail express must bear the label prescribed by § 73.412.

(g) Each package of explosives must be marked with the I.C.C specification number as prescribed by the specification, if an I.C.C. specification container is required.

§ 73.401 **Dangerous articles.** (a) Packages containing flammable liquids, flammable solids, oxidizing materials, corrosive liquids, compressed gases, and poisons, as defined in this part must be marked, unless exempted, with the proper shipping name as shown in the commodity list (see § 72.5). For tank cars this marking must appear either on the placards or commodity cards.

(1) Every portable tank used for the transportation of any dangerous article shall be conspicuously and legibly marked on a background of sharply contrasting color with a sign or lettering on the tank with words as appropriate "CORROSIVE LIQUID," "COMPRESSED GAS," or "FLAMMABLE COMPRESSED GAS" and with the proper shipping name as shown in the commodity list (see § 72.5); the height of all required lettering shall be at least 2 inches or 1/10 the diameter of the tank, whichever is the greater; every portable tank container shall be marked with the owner's name; in addition to the markings hereinbefore required, there may be marked on any portable tank container the trademark appropriate to the commodity being transported therein: **Provided, however,** That no such marking shall be of such size and character as to render inconspicuous the required markings. No markings either required or permitted under the terms of this subparagraph shall be in lieu of any other marking or markings required by the Commission

(b) Each package of dangerous articles must show the name and address of the consignee except in carloads and truckloads or less-than-truckloads when handled by a motor vehicle not requiring transfer from one motor carrier to another.

(c) Packages containing flammable liquids in inside containers of 1 quart capacity or larger, or corrosive liquids, acids, alkaline caustic liquids, liquid oxidizing materials and poisonous liquids in inside containers regardless of capacity, unless specifically exempted or otherwise provided in this part, must be packed with filling holes up, and except for carboys not completely boxed, the outside container must be plainly marked "THIS SIDE UP" or "THIS END UP" on the cover or top to indicate the position of the inside containers. This requirement does not apply to materials in inside metal cans of the nonrefillable type with spun-in head and base and having no replaceable cap or other closing device.

(d) Each package must show the specification marking as required if a specification container is prescribed.

(e) Additional shipping information not inconsistent with Parts 71-78 may be shown on a container if so desired but no such label or marking shall be of a design, or form, or size, as may be confused with the marking required by Parts 71-78.

§ 73.402 **Labeling dangerous articles.** (a) Each package containing any dangerous article as defined by Parts 71-78 must be conspicuously labeled by the shipper as follows, except as otherwise provided:

(1) "Red label" as described in § 73.405 on containers of flammable liquids, except when exempted from the regulations by § 73.118. If flammable liquid is also a class A poison or a radioactive material poison D, the "poison gas" label or "Radioactive materials" label must also be applied to the package.

(2) "Yellow label" as described in § 73.406 on containers of flammable solids and oxidizing materials, except when exempted from the regulations by § 73.153 and § 73 183. If flammable solid or oxidizing material is also a class A poison or a radioactive material poison D, the "poison gas" label or "radioactive materials" label must also be applied to the package.

(3) "White label" as described in § 73.407 (a) (1), (2) and (3) on containers of acids, alkaline caustic liquids or corrosive liquids, except when exempted from regulations by § 73.244. If the acid, alkaline caustic liquid or corrosive liquid is also a class A poison or a radioactive material poison D, the "poison gas" label or "radioactive materials" label must also be applied to the package.

(4) "Red label" as described in § 73.408 (a) (1) on containers of flammable compressed gases, except when exempted from the regulations by § 73.302. If the flammable compressed gas is also a class A poison or a radioactive material poison D, the "poison gas" label or "radioactive materials" label must also be applied to the package.

(5) "Green label" as described in § 73.408 (a) (2) on containers of nonflammable compressed gases, except when exempted from the regulations by § 73.302. If the nonflammable compressed gas is also a class A poison or a radioactive material poison D, the "poison gas" label or "radioactive materials" label must also be applied to the package.

(6) "Poison gas" label as described in § 73.409 (a) (1) on containers of class A poisons.

(7) "Poison" label as described in § 73.409 (a) (2) on containers of class B poison liquids or solids, except when exempted from the regulations by § 73.345 and § 73.364. If the class B poison liquid or solid is also a radioactive material poison D, the "radioactive materials" label must also be applied to the package.

(8) "Radioactive Materials" label as described in § 73.414 (a) on containers of class D poisons, Group I and II except when exempted by § 73.392.

(9) "Radioactive Materials" label as described in § 73.414 (b) on containers of class D poisons, Group III, except when exempted by § 73.392.

(10) "Tear gas" label as described in § 73.409 (a) (3) on containers of poisons, class C.

(11) "Bung label" as described in § 73.119 (i) of this part on metal barrels or drums containing flammable liquids with vapor pressure exceeding 16 pounds per square inch absolute.

(12) "Empty label" as described in § 73.413 of this part must be applied to containers which have been emptied and on which the old label has not been removed, obliterated, or destroyed. It must be so placed on the container as to completely cover the old label.

(13) Labels prescribed for shipments of explosives and other dangerous articles by air between the United States, its territories and possessions, and other countries, as shown in §§ 73.405 (b), 73.406 (b), 73.407 (b), 73.408 (b), 73.409 (b), 73.410 (b), 73.411 (b), 73.412 (b) and 73.414 (c), may be used in lieu of labels otherwise prescribed and for local transportation to or from airport.

(b) Labels when applied to packages offered for transportation by rail express, rail baggage, or other forms of transportation for which a certified shipping order, bill of lading, or other shipping paper is not required, must show shipper's name in printing, stamping, or writing underneath the certificate printed thereon.

(1) Labels prescribed for shipments of explosives or other dangerous articles by air between the United States, its territories, possessions and other countries, as shown in §§ 73.405 (b), 73.406 (b), 73.407 (b), 73.408 (b), 73.409 (b), 73.410 (b), 73.411 (b), 73.412 (b) and 73.414 (c) are authorized. Such shipments must be tendered with a signed certificate, in duplicate, reading as follows: (one signed copy shall be retained by the original carrier):

This is to certify that the contents of this package are properly described by name and are packed and marked and are in proper condition for transportation according to the regulations prescribed by the Interstate Commerce Commission and the Civil Aeronautics Board. (For shipment on passenger-carrying aircraft the following must be added to certificate: This shipment is within the limitations prescribed for passenger-carrying aircraft.)

(c) Labels and marking name of contents are not required on carload or truckload quantities of dangerous articles, except class A, class C, or class D poisons, by rail freight, rail express, or highway, when such shipments are unloaded by the consignee or his duly authorized agent from the car or motor vehicle in which originally loaded.

(1) Carload or truckload shipments of class A, class B, class C, or class D poisons offered for transportations by, for, or to the Departments of the Army, Navy, and Air Force of the United States Government are exempt from labeling requirements when shipments are loaded or unloaded by the shipper or his duly authorized agent and such shipments are accompanied by qualified personnel supplied with equipment to repair leaks or other container failure which will permit escape of contents.

(d) Except on class A, class C, or class D poisons, labels are not required on less-than-truckload shipments by motor vehicle by public highway when the articles are readily identifiable by reason of type of container or when the container is plainly marked to indicate its contents and;

(1) When the shipment is transported from origin to destination without transfer between vehicles and;

(2) When the shipper or its employees are in direct control or perform the loading, transporting and unloading.

(e) When it is known that subsequent shipments of these packages may be made by consignees in less-than-carolad or less-than-truckload quanties, or in carload or truckload quantities to a point where they may be handled by other than the original consignee, the original shipper should attach labels to the packages as would be required for less-than-carload or less-than-truckload shipments.

§ 73.403 Labels for mixed packing. (a) Use red label only when red and other labels are prescribed except when poison gas label or radioactive materials label are prescribed then both the red label and the poison gas label or red label and radioactive materials label must be used.

(b) Use White acid (alkaline caustic liquid or corrosive liquid) label only when white acid (alkaline caustic liquid or corrosive liquid) and yellow or poison labels are prescribed or poison labels (class B) are prescribed, except when poison gas label or radioactive materials label are prescribed then both the white acid label and the poison gas label or white acid and radioactive materials label must be used.

(c) Use yellow label only when yellow and poison labels are prescribed except when poison gas label or radioactive materials label are prescribed then both the yellow label and the poison gas label or the yellow label and the radioactive materials label must be used.

§ 73.404 Labels. (a) Shippers must furnish and attach the labels prescribed for their packages. Labels should be applied to that part of the package bearing consignee's name and address.

(b) Labels must not be applied to packages containing articles which are not subject to Parts 71-78 or are exempted therefrom.

(c) Shippers must not use labels which by their size, shape, and color, may readily be confused with the standard caution labels prescribed in this part.

(d) Labels must conform to standards as to size, printing, and color, and samples will be furnished, on request, by the Bureau of Explosives.

(e) A combination diamond-shaped label-tag of proper size and color, bearing on one side the shipping information and on the reverse side the wording prescribed in this part, will be permitted.

(f) As certification of compliance with regulations is also required by other Government agencies, and to avoid multiplicity of certifications, there may be added to the certificate on labels "and the Commandant of the Coast Guard," or "and the Civil Air Regulations," or "and the Post Office Department," as is necessary.

(g) The carrier's name and stationery form number, or the shipper's name and address, may be printed on the labels, in type not larger than 10 point, if placed within the black-line border and in the upper or lower corner of the diamond.

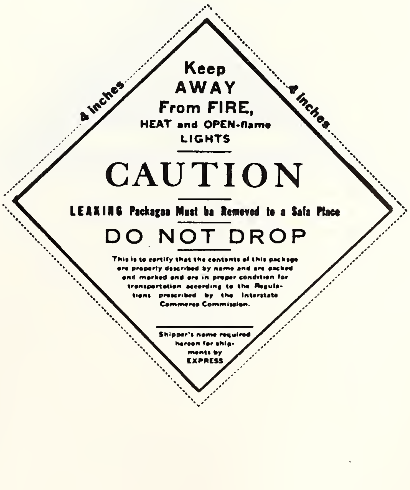
(h) Labels remaining on hand and which were authorized by regulations in effect on December 31, 1950, may be used until present stocks are exhausted.

§ 73.405 Flammable liquids label. (a) Labels for flammable liquids must be of diamond shape, bright red in color, and with each side 4 inches long. Printing must be in black letters inside of a black-line border measuring 3½ inches on each side and as shown in this section.

RED LABEL FOR FLAMMABLE LIQUIDS

(Reduced size)

(Black printing on red)


4 inches
4 inches

Keep
AWAY
From FIRE,
HEAT and OPEN-flame
LIGHTS

CAUTION

LEAKING Packages Must be Removed to a Safe Place

DO NOT DROP

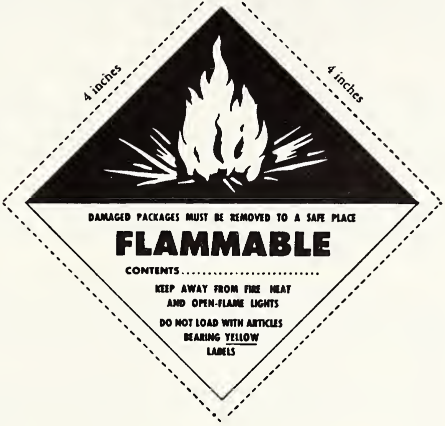
This is to certify that the contents of this package are properly described by name and are packed and marked and are in proper condition for transportation according to the Regulations prescribed by the Interstate Commerce Commission.

Shipper's name required hereon for shipments by EXPRESS

(b) Red label for flammable liquids for shipment by air.

(Reduced size)

Red and black with (black printing on red)

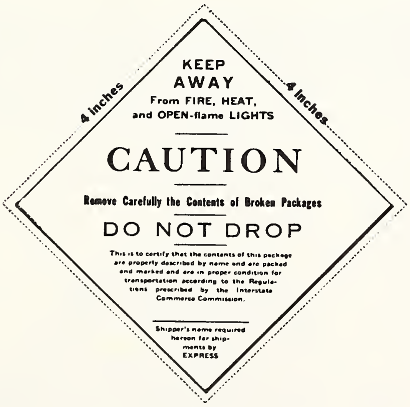

4 inches
4 inches
DAMAGED PACKAGES MUST BE REMOVED TO A SAFE PLACE
FLAMMABLE
CONTENTS..........................
KEEP AWAY FROM FIRE HEAT
AND OPEN-FLAME LIGHTS
DO NOT LOAD WITH ARTICLES
BEARING YELLOW
LABELS

§ 73.406 **Flammable solids and oxidizing materials label.** (a) Labels for flammable solids and oxidizing materials must be of diamond shape, bright yellow in color, and with each side 4 inches long. Printing must be in black letters inside of a black-line border measuring 3½ inches on each side and as shown in this section.

YELLOW LABEL FOR FLAMMABLE SOLIDS AND OXIDIZING MATERIALS

(Reduced size)

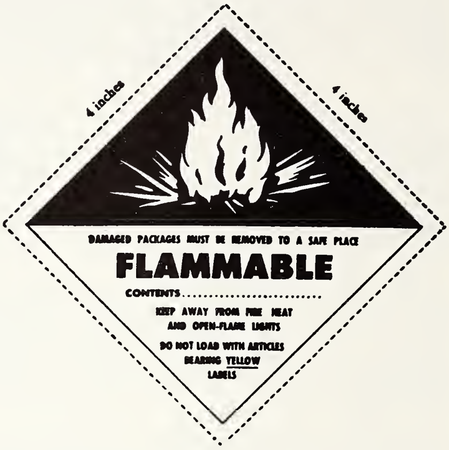
(Black printing on yellow)


4 inches
4 inches
KEEP
AWAY
From FIRE, HEAT,
and OPEN-flame LIGHTS
CAUTION
Remove Carefully the Contents of Broken Packages
DO NOT DROP
This is to certify that the contents of this package are properly described by name and are packed and marked and are in proper condition for transportation according to the Regulations prescribed by the Interstate Commerce Commission.
Shipper's name required hereon for shipments by EXPRESS

(b) Yellow label for flammable solids for shipment by air.

(Reduced size)

Yellow and black with (black printing on yellow)

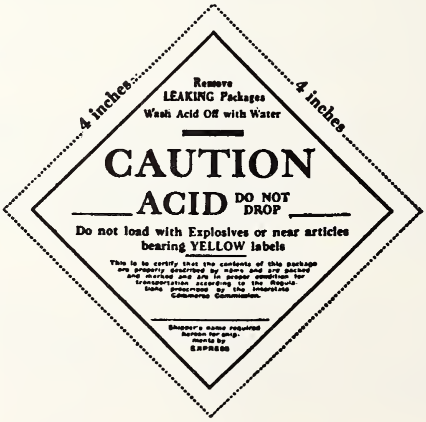

4 inches
4 inches
DAMAGED PACKAGES MUST BE REMOVED TO A SAFE PLACE
FLAMMABLE
CONTENTS..........................
KEEP AWAY FROM FIRE HEAT
AND OPEN-FLAME LIGHTS
DO NOT LOAD WITH ARTICLES
BEARING YELLOW
LABELS

§ 73.407 **Acids, corrosive liquids, and alkaline caustic liquids labels.** (a) Labels for corrosive liquids, acids and alkaline caustic liquids must be of diamond shape, white in color, and with each side 4 inches long. Printing must be in black letters inside of a black-line border measuring 3½ inches on each side and as shown in this section.

(1) WHITE LABEL FOR ACIDS:

(Reduced size)

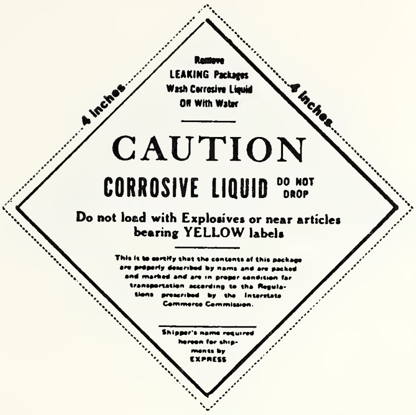
(Black printing on white)


4 inches
4 inches
Remove
LEAKING Packages
Wash Acid Off with Water
CAUTION
ACID DO NOT DROP
Do not load with Explosives or near articles bearing YELLOW labels
This is to certify that the contents of this package are properly described by name and are packed and marked and are in proper condition for transportation according to the Regulations prescribed by the Interstate Commerce Commission.
Shipper's name required hereon for shipments by EXPRESS

(2) WHITE LABEL FOR CORROSIVE LIQUIDS:

(Reduced size)

(Black printing on white)



Remove
LEAKING Packages
Wash Corrosive Liquid
Off With Water

CAUTION

CORROSIVE LIQUID DO NOT DROP

Do not load with Explosives or near articles bearing YELLOW labels

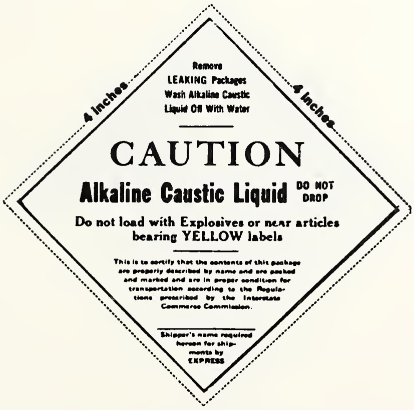
This is to certify that the contents of this package are properly described by name and are packed and marked and are in proper condition for transportation according to the Regulations prescribed by the Interstate Commerce Commission.

Shipper's name required hereon for shipments by EXPRESS

(3) WHITE LABEL FOR ALKALINE CAUSTIC LIQUIDS:

(Reduced size)

(Black printing on white)



Remove
LEAKING Packages
Wash Alkaline Caustic
Liquid Off With Water

CAUTION

Alkaline Caustic Liquid DO NOT DROP

Do not load with Explosives or near articles bearing YELLOW labels

This is to certify that the contents of this package are properly described by name and are packed and marked and are in proper condition for transportation according to the Regulations prescribed by the Interstate Commerce Commission.

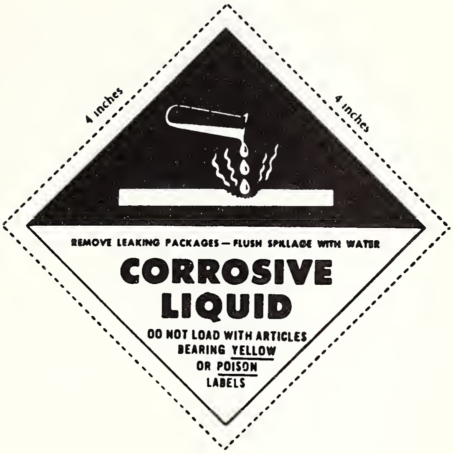
Shipper's name required hereon for shipments by EXPRESS

(b) Labels for shipments of acids, corrosive liquids, and alkaline caustic liquids by air must be as shown in the following:

(1) White label for acids for shipment by air.

(Reduced size)

White and black with (black printing on white)

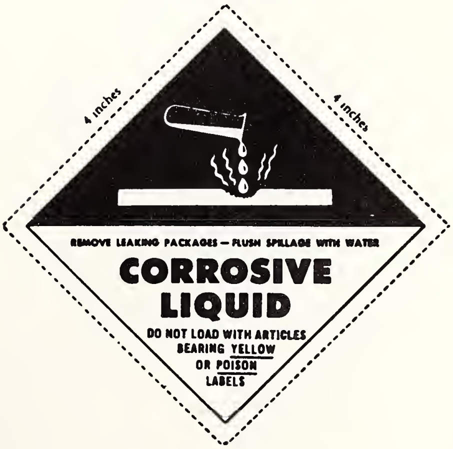


4 inches
4 inches
REMOVE LEAKING PACKAGES — FLUSH SPILLAGE WITH WATER
CORROSIVE
LIQUID
DO NOT LOAD WITH ARTICLES
BEARING YELLOW
OR POISON
LABELS

(2) White label for corrosive liquids for shipment by air.

(Reduced size)

White and black with (black printing on white)

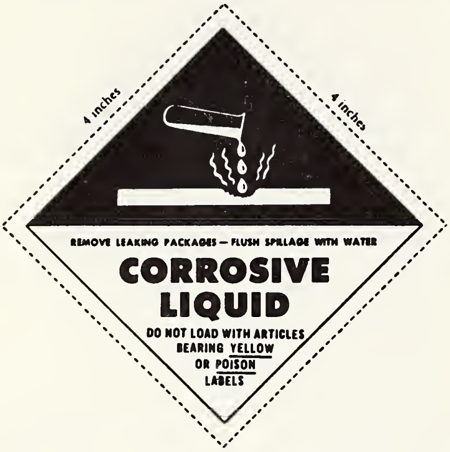


4 inches
4 inches
REMOVE LEAKING PACKAGES — FLUSH SPILLAGE WITH WATER
CORROSIVE
LIQUID
DO NOT LOAD WITH ARTICLES
BEARING YELLOW
OR POISON
LABELS

(3) White label for alkaline caustic liquids for shipment by air.

(Reduced size)

White and black with (black printing on white)

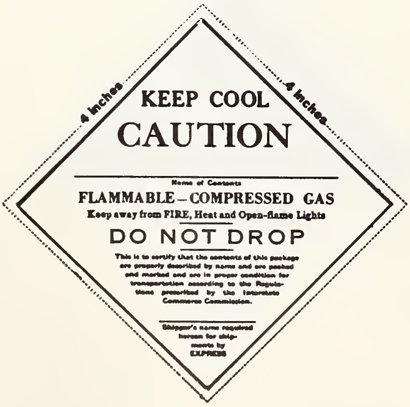

4 inches
4 inches
REMOVE LEAKING PACKAGES — FLUSH SPILLAGE WITH WATER
CORROSIVE
LIQUID
DO NOT LOAD WITH ARTICLES
BEARING YELLOW
OR POISON
LABELS

§ 73.408 Compressed gas labels. (a) Labels for compressed gases must be of diamond shape, bright red in color for flammable gases and bright green for nonflammable gases, and with each side 4 inches long. Printing must be in black letters inside of a black-line border measuring 3½ inches on each side and as shown in this section.

(1) RED LABEL FOR FLAMMABLE GASES.

(Reduced size)

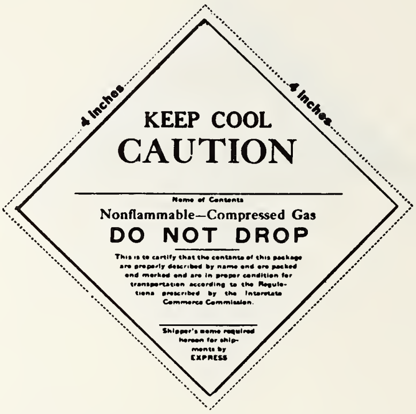
(Black printing on red)


4 inches
4 inches
KEEP COOL
CAUTION
Name of Contents
FLAMMABLE – COMPRESSED GAS
Keep away from FIRE, Heat and Open-flame Lights
DO NOT DROP
This is to certify that the contents of this package are properly described by name and are packed and marked and are in proper condition for transportation according to the Regulations prescribed by the Interstate Commerce Commission.
Shipper's name required hereon for shipments by EXPRESS

(2) GREEN LABEL FOR NONFLAMMABLE GASES:

(Reduced size)

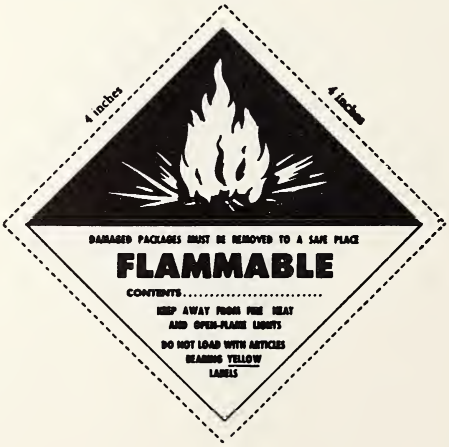
(Black printing on green)


4 Inches
4 Inches
KEEP COOL
CAUTION
Name of Contents
Nonflammable—Compressed Gas
DO NOT DROP
This is to certify that the contents of this package are properly described by name and are packed and marked and are in proper condition for transportation according to the Regulations prescribed by the Interstate Commerce Commission.
Shipper's name required hereon for shipments by EXPRESS

(b) Red label for flammable gases for shipment by air.

(Reduced size)

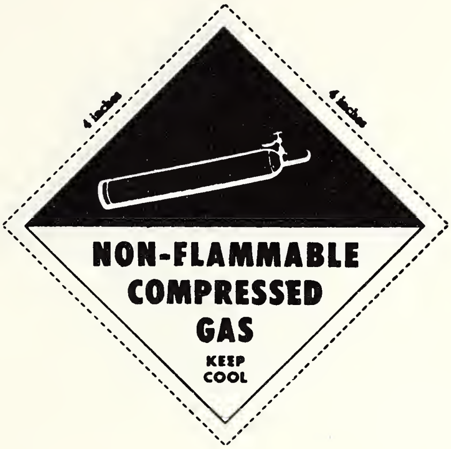
Red and black with (black printing on red)


4 inches
4 inches
DAMAGED PACKAGES MUST BE REMOVED TO A SAFE PLACE
FLAMMABLE
CONTENTS.............................
KEEP AWAY FROM FIRE HEAT
AND OPEN-FLAME LIGHTS
DO NOT LOAD WITH ARTICLES
BEARING YELLOW
LABELS

(1) Green label for nonflammable gases for shipment by air.

(Reduced size)

Green and black with (black printing on green)

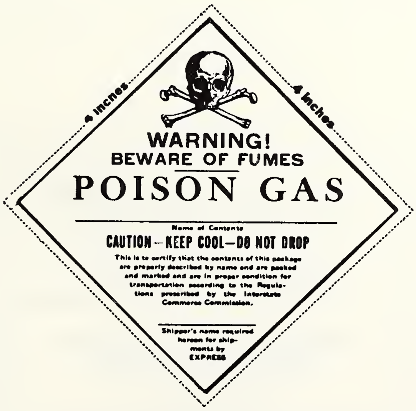


§ 73.409 **Poisonous articles and tear gas labels.** (a) Labels for poisonous articles and tear gases must be of diamond shape, white in color, and with each side 4 inches long. Printing must be in red letters inside of a red-line border measuring 3½ inches on each side and as shown in this section.

(1) POISON GAS LABEL.

(Reduced size)

(Red printing on white)

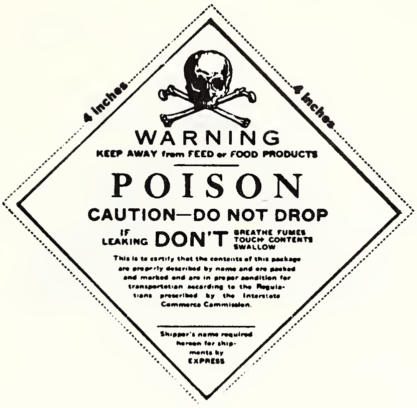


4 inches
4 inches
WARNING!
BEWARE OF FUMES
POISON GAS
Name of Contents
CAUTION—KEEP COOL—DO NOT DROP
This is to certify that the contents of this package are properly described by name and are packed and marked and are in proper condition for transportation according to the Regulations prescribed by the Interstate Commerce Commission.
Shipper's name required hereon for shipments by EXPRESS

(2) POISON LABEL.

(Reduced size)

(Red printing on white)

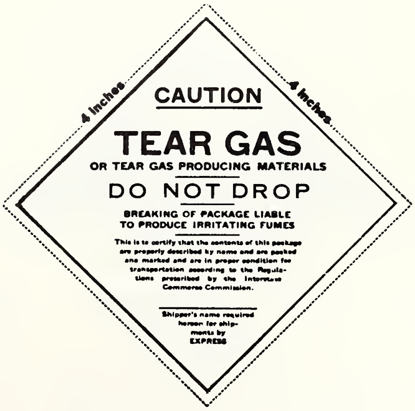


4 inches
4 inches
WARNING
KEEP AWAY from FEED or FOOD PRODUCTS
POISON
CAUTION—DO NOT DROP
IF LEAKING DON'T BREATHE FUMES TOUCH CONTENTS SWALLOW
This is to certify that the contents of this package are properly described by name and are packed and marked and are in proper condition for transportation according to the Regulations prescribed by the Interstate Commerce Commission.
Shipper's name required hereon for shipments by EXPRESS

(3) TEAR GAS LABEL.

(Reduced size)

(Red printing on white)



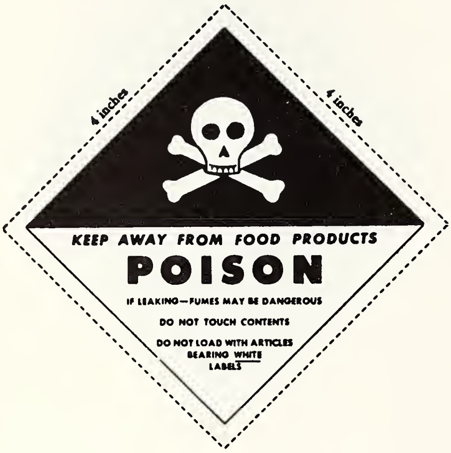
4 inches
4 inches
CAUTION
TEAR GAS
OR TEAR GAS PRODUCING MATERIALS
DO NOT DROP
BREAKING OF PACKAGE LIABLE TO PRODUCE IRRITATING FUMES
This is to certify that the contents of this package are properly described by name and are packed and marked and are in proper condition for transportation according to the Regulations prescribed by the Interstate Commerce Commission.
Shipper's name required hereon for shipments by EXPRESS

(b) Labels for shipments of poisonous articles and tear gases by air must be shown in the following:

(1) Label for poison gas for shipment by air.

(Reduced size)

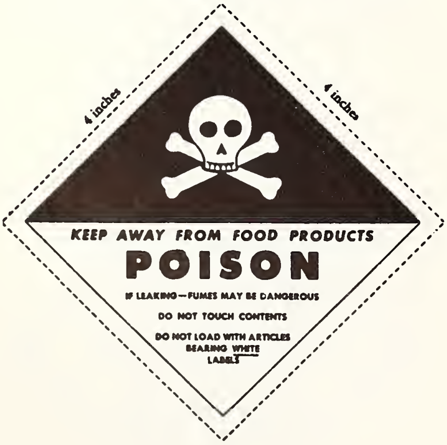
White and red with (red printing on white)


4 inches
4 inches
KEEP AWAY FROM FOOD PRODUCTS
POISON
IF LEAKING—FUMES MAY BE DANGEROUS
DO NOT TOUCH CONTENTS
DO NOT LOAD WITH ARTICLES BEARING WHITE LABELS

(2) Label for poisons for shipment by air.

(Reduced size)

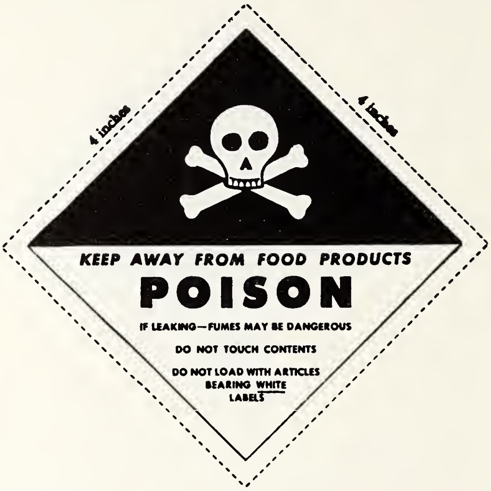
White and red with (red printing on white)


4 inches
4 inches
KEEP AWAY FROM FOOD PRODUCTS
POISON
IF LEAKING—FUMES MAY BE DANGEROUS
DO NOT TOUCH CONTENTS
DO NOT LOAD WITH ARTICLES BEARING WHITE LABELS

(3) Label for tear gas for shipment by air.

(Reduced size)

White and red with (red printing on white)

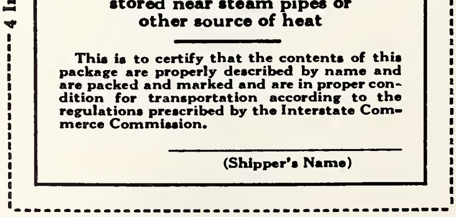

4 inches
4 inches
KEEP AWAY FROM FOOD PRODUCTS
POISON
IF LEAKING—FUMES MAY BE DANGEROUS
DO NOT TOUCH CONTENTS
DO NOT LOAD WITH ARTICLES BEARING WHITE LABELS

§ 73.410 Special fireworks label. (a) Labels for special fireworks must be square measuring 4 inches on each side and bright red in color. Printing must be in black letters inside of a black-line border measuring 3½ inches on each side as shown in this section.

RED LABEL FOR SPECIAL FIREWORKS

(Reduced size)

(Black printing on red)


4 Inches
4 Inches

SPECIAL FIREWORKS

HANDLE CAREFULLY
KEEP FIRE AWAY
DO NOT DROP NOR THROW

This package must not be loaded or stored near steam pipes or other source of heat

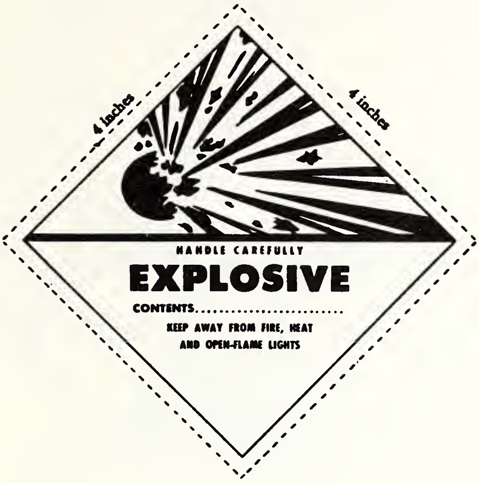
This is to certify that the contents of this package are properly described by name and are packed and marked and are in proper condition for transportation according to the regulations prescribed by the Interstate Commerce Commission.

(Shipper's Name)

(b) Explosives label for shipment of Special fireworks by air.

(Reduced size)

(Black printing on red)

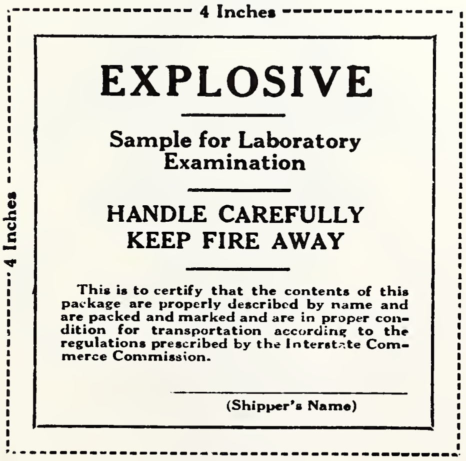


§ 73.411 **Explosives samples for laboratory examination label.** (a) Labels for samples of explosives for laboratory examination must be square measuring 4 inches on each side and bright red in color. Printing must be in black letters inside of a black-line border measuring 3½ inches on each side and as shown in this section.

RED LABEL FOR SAMPLE OF EXPLOSIVES

(Reduced size)

(Black printing on red)


4 Inches
4 Inches

EXPLOSIVE

Sample for Laboratory Examination

HANDLE CAREFULLY
KEEP FIRE AWAY

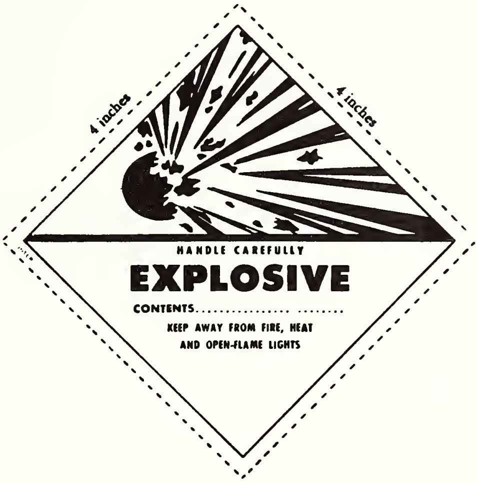
This is to certify that the contents of this package are properly described by name and are packed and marked and are in proper condition for transportation according to the regulations prescribed by the Interstate Commerce Commission.

(Shipper's Name)

(b) Explosives label for shipment of samples of explosives by air.

(Reduced size)

(Black printing on red)

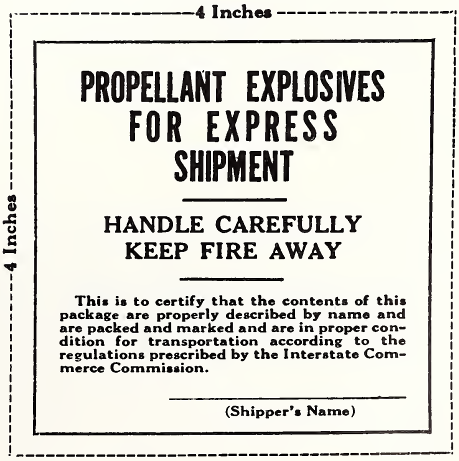


§ 73.412 **Propellant explosives label for express shipment.** (a) Label for propellant explosives must be square measuring 4 inches on each side and bright red in color. Printing must be in black letters inside of a black-line border measuring 3½ inches on each side and as shown in this section.

(1) RED LABEL FOR PROPELLANT EXPLOSIVE FOR EXPRESS SHIPMENT

(Reduced size)

(Black printing on red)


4 Inches
4 Inches

PROPELLANT EXPLOSIVES
FOR EXPRESS
SHIPMENT

HANDLE CAREFULLY
KEEP FIRE AWAY

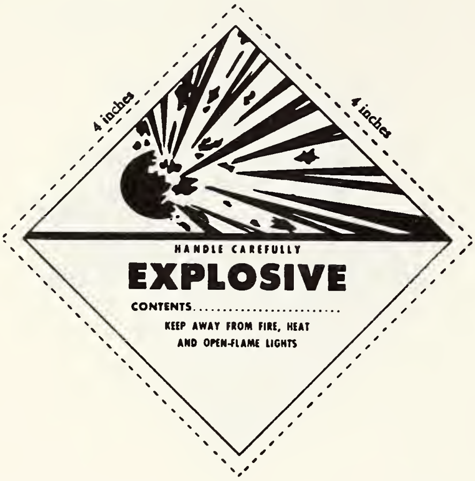
This is to certify that the contents of this package are properly described by name and are packed and marked and are in proper condition for transportation according to the regulations prescribed by the Interstate Commerce Commission.

(Shipper's Name)

(b) Explosives label for shipment of Propellant explosives by air.

(Reduced size)

(Black printing on red)

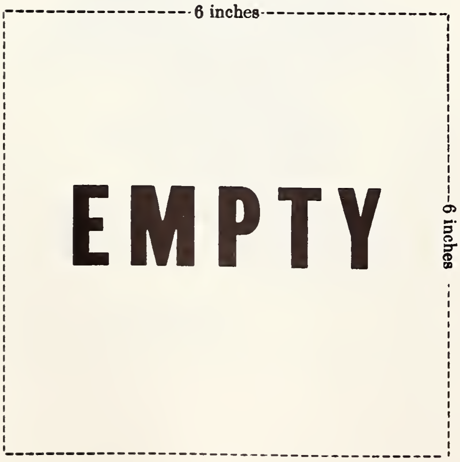


§ 73.413 Empty container label. (a) Labels for empty containers must be not less than 6 inches on each side, white in color, and printed in letters not less than 1 inch high in black ink and as shown in this section.

WHITE LABEL FOR EMPTY CONTAINERS

(Reduced size)

(Black printing on white)

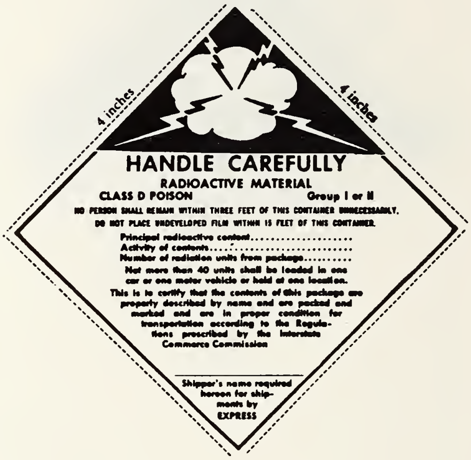


§ 73.414 **Radioactive materials labels.** (a) Labels for radio-active materials (class D poisons) Group I and Group II must be of diamond shape, white in color, and with each side 4 inches long. Printing must be in red letters inside of a red-line border measuring 3½ inches on each side, as shown in this section.

LABEL FOR RADIOACTIVE MATERIALS
GROUP I OR II

(Reduced size)

(Red printing on white)


4 inches
4 inches
HANDLE CAREFULLY
RADIOACTIVE MATERIAL
CLASS D POISON
Group I or II
NO PERSON SHALL REMAIN WITHIN THREE FEET OF THIS CONTAINER UNNECESSARILY.
DO NOT PLACE UNDEVELOPED FILM WITHIN 15 FEET OF THIS CONTAINER.
Principal radioactive content....................
Activity of contents.........................
Number of radiation units from package..........
Not more than 40 units shall be loaded in one car or one motor vehicle or held at one location.
This is to certify that the contents of this package are properly described by name and are packed and marked and are in proper condition for transportation according to the Regulations prescribed by the Interstate Commerce Commission
Shipper's name required hereon for shipments by EXPRESS

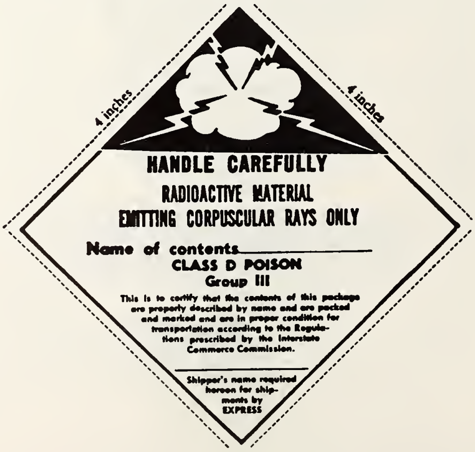
NOTE. This label must be duly executed by the shipper and the number of radiation units must be shown. For purposes of these regulations 1 unit equals 1 miliroentgen per hour at 1 meter for hard gamma radiation or the amount of radiation which has the same effect on film as 1 mrhm or hard gamma rays of radium filtered by ½ inch of lead.

(b) Labels for radioactive materials (class D poisons) Group III must be of diamond shape, white in color, and with each side 4 inches long. Printing must be in blue letters inside of a blue-line border measuring 3½ inches on each side, and as shown in this section.

LABEL FOR RADIOACTIVE MATERIALS
GROUP III

(Reduced size)

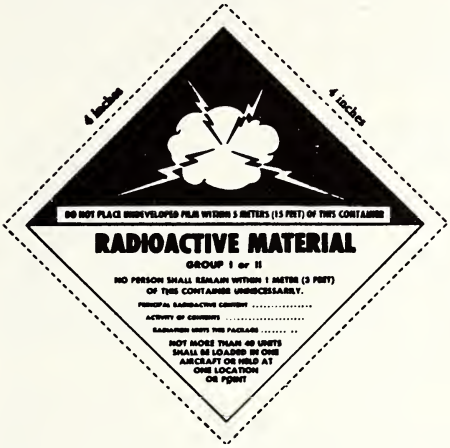
(Blue printing on white)


4 inches
4 inches
HANDLE CAREFULLY
RADIOACTIVE MATERIAL
EMITTING CORPUSCULAR RAYS ONLY
Name of contents
CLASS D POISON
Group III
This is to certify that the contents of this package are properly described by name and are packed and marked and are in proper condition for transportation according to the Regulations prescribed by the Interstate Commerce Commission.
Shipper's name required hereon for shipments by EXPRESS

(c) Label for Radioactive Materials Groups I and II for shipment by air.

(Reduced size)

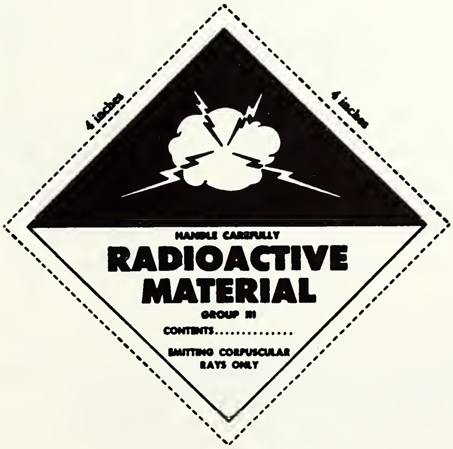
Red and white with (red printing on white)


4 inches
4 inches
DO NOT PLACE UNDEVELOPED FILM WITHIN 5 METERS (15 FEET) OF THIS CONTAINER
RADIOACTIVE MATERIAL
GROUP I or II
NO PERSON SHALL REMAIN WITHIN 1 METER (3 FEET) OF THIS CONTAINER UNNECESSARILY.
PRINCIPAL RADIOACTIVE CONTENT ....
ACTIVITY OF CONTENTS ....
RADIATION UNITS THIS PACKAGE ....
NOT MORE THAN 40 UNITS SHALL BE LOADED IN ONE AIRCRAFT OR HELD AT ONE LOCATION OR POINT

(l) Label for Radioactive Materials Group III for shipment by air.

(Reduced size)

Blue and white with (blue printing on white)



SUPART I — SHIPPING INSTRUCTIONS

§ 73.425 **"Order-Notify," "C. O. D.," and "Stop-off" shipments.** (a) Except on through bills of lading to a foreign country, shipments of explosives, class A and blasting caps in any quantity must not be offered for transportation by carriers by rail freight or rail express when consigned "to order notify" or "C.O.D." Shippers must not consign these shipments to themselves at points where they have not a resident representative.

(b) Explosives, class A must not be offered for transportation by carriers by rail freight or rail express subject to "stop-off" privileges en route for partial loading or unloading.

§ 73.426 **Cars containing lading which has been fumigated or treated with flammable liquids, flammable gases, poisonous liquids or solids, or poisonous gases.** (a) Delivery to carrier of cars containing lading fumigated or treated with flammable liquid or flammable gas is prohibited until 48 hours have elapsed after such fumigation or treatment, or until car has been ventilated so as to remove danger of fire or explosion due to the presence of flammable vapors.

(b) Cars containing lading which has been fumigated or treated with poisonous liquid, solid, or gas, such as carbolic acid, liquid or solid, chlorpicrin, hydocyanic acid, methyl bromide, etc., must be placarded on each door or near thereto with placard reading as follows (for cleaning cars, see § 74.566):

(Reduced size)

(Red lettering on white cardboard)

10 INCHES

8 INCHES

DANGER

The lading of this car has been

FUMIGATED or TREATED

with

(Name of poisonous liquid, solid, or gas)

BEFORE UNLOADING, open both doors and DO NOT ENTER until car is free of gas. REMOVE ALL POISONOUS MATERIAL before release of empty car.

§ 73.427 **Shipping order and bill of lading description.** (a) The shipper when offering for transportation by carriers by rail freight, rail express, highway, or water any class A, class B, or class C explosive, flammable liquid, flammable solid, oxidizing material, corrosive liquid, compressed gas, or poison, as defined by this part, must describe such article in the shipping order, bill of lading or other shipping paper by the shipping name used in § 72.5 (see commodity list) and may add a further description not inconsistent therewith. Abbreviations must not be used. For shipments of blasting caps and/or electric blasting caps the shipper must, in addition, show the number of caps in the shipment.

NOTE 1: In commodity list (§72.5) shipping names are shown in roman, not italics:

§ 73.428 **Label or placard notation.** (a) The shipping order, bill of lading or other shipping paper must also show thereon in connection with the entry of the article as prescribed in § 73.427 of this part, the color or kind of label applied, and for cars containing such articles loaded by the shipper, requiring placards the kind of placard applied to the car.

§ 73.429 **Receipts; rail express shipments.** (a) A recepit upon the form prescribed by the originating rail express carrier must be issued to the shipper for each express shipment of explosives or other dangerous articles accepted for transportation. Before a receipt is isuued, the shipper must apply the label prescribed in this part to each package containing any article requiring a label under Parts 71-78.

(b) Each receipt must show the proper and definite name of commodity, as listed in § 72.5, and the color or kind of label applied to the package if any is required. Abbreviations must not be used.

§ 73.430 **Certificate.** (a) The shipper offering for transportation by carriers by rail freight, highway, water, or air, any class A or class B explosive and blasting caps or electric blasting caps in any quantity, and any flammable liquid, flammable solid, oxidizing material, corrosive liquid, compressed gas, or poison, requiring labels, or carloads requiring placards, as prescribed by Parts 71-78, must show on the shipping order, bill of lading, or other shipping paper, in the lower left-hand corner, the following certificate over the written or stamped facsimile signature of the shipper or his duly authorized agent:

This is to certify that the above named articles are properly described, and are packed and marked and are in proper condition for transportation according to the regulations prescribed by the Interstate Commerce Commission.

(b) For the relief of shippers from multiplicity of certifications required for packages which may move by various means of transportation, shipments may be certified for rail, motor vehicle, water, or air transportation by adding to the certificate required on the shipping document "and the Commandant of the Coast Guard," or "and the Civil Air Regulations," as the case may be.

(c) Shipping papers for shipments made by air between the United States and other countries shall be certified in duplicate with certificate signed by the shipper reading as follows:

This is to certify that the contents of this package are properly described by name and are packed and marked and are in proper condition for transportation according to the regulations prescribed by the Interstate Commerce Commission and the Civil Aeronautics Board. (For ship ment on passenger-carrying aircraft the following must be added to certificate: This shipment is within the limitations prescribed for passenger carrying aircraft.)

§ 73.431 **Switching ticket.** (a) When the initial movement is a switching operation, the switching order, switching receipts or switching ticket, and copies thereof, prepared by the shipper, must bear the placard indorsement and the shipper's certificate prescribed by §§ 73.430 and 74.584 (a) and (b).

§ 73.432 **Tank car shipments.** (a) Tank cars containing flammable liquids having a flash point of 80°F. or below, except liquid road asphalt or tar, must not be offered for shipment unless originally consigned or subsequently reconsigned to parties having private-siding (see Note 1 of this section) or to parties using railroad-siding facilities which have been equipped for piping the liquid from tank cars to permanent storage tanks of sufficient capacity to receive contents of car.

(b) A tank car containing any compressed gas must not be offered for transportation unless the car is consigned for delivery (see paragraph (c) of this section) and unloading on a private track (see Note 1 of this section), except that where no private track is available, delivery and unloading on carrier tracks is permitted provided the following conditions are complied with:

(1) Any tank car of ICC-106A or 110A type (see §§ 78.275, 78.276 or 78.293) may be offered for transportation and the loaded unit tanks may be removed from car frame on carrier tracks, provided the shipper has obtained from the delivering carrier and filed with originating carrier, written permission (see Note 2 of this section) for such removal. The consignee must furnish adequately safe mechanical hoist, obtained from the carrier if desirable, by which the tanks shall be lifted from the car and deposited directly upon vehicles furnished by the consignee for immediate removal from carrier property or tanks must be lifted by adequately safe mechanical hoist from car directly to vessels for further transportation.

(c) Any tank car of other than ICC-106A or 110A type (see §§ 78.275, 78.276 or 78.293), containing anhydrous ammonia, liquefied hydrocarbon or liquefied petroleum gas, and having interior pipes of liquid and gas discharge valves equipped with check valves, may be consigned for delivery and unloading on carrier tracks, if the lading is piped directly from the car to permanent storage tanks of sufficient capacity to receive the entire contents of the car. Such cars may also be consigned for storage on a private track or on a carrier track when designated by the carrier for such storage.

(d) For cars of the ICC-106A or 110A type (see §§ 78.275, 78.276 or 78.293), the tanks must be placed in position and attached to the car structure by the shipper.

(e) Flammable liquids must not be loaded into tank cars on carriers' property from tank trucks, wagons or drums.

NOTE 1: For this purpose, a private track is a track outside of carrier's right-of-way, yard, and terminals, and of which the carrier does not own either the rails, ties, roadbed or right-of-way; or a track or portion of a track which is devoted to the purpose of its user, either by lease or written agreement; in which case the lease or written agreement will be considered as equivalent to ownership.

NOTE 2: Carriers should give permission for the unloading of these containers on carrier tracks only where no private siding is available within reasonable trucking distance of final destination. The danger involved is the release of chlorine gas due to accidental injury to container in handling. The exposure to this danger decreases directly with the isolation of the unloading point.

PART 74 — REGULATIONS APPLYING PARTICULARLY TO CARRIERS BY RAIL FREIGHT

Sec.

74.500 Purpose of the regulations in Parts 71-78.

74.501 Acceptable articles.

74.502 Forbidden explosives.

74.503 "Order—notify," "C. O. D.," and "Stop-off" shipments.

74.504 Carrier's material and supplies.

74.505 Canadian shipments.

74.506 Improperly packed or damaged shipments in transportation.

74.507 Labels.

74.508 Violations and accidents to be reported.

Sec.

74.509 Quantity limitations.

Subpart A — Loading, Unloading, Placarding and Handling Cars; Loading Packages into Cars

74.525 Loading packages of explosives in cars, selection, preparation, inspection and certification.

74.526 Loading explosives into cars.

74.527 Forbidden mixed loading and storage

74.528 Protect explosives from injury.

74.529 Cars for class B, explosives.

74.530 Cars for class C, explosives.

74.531 Lights.

Sec.
74.532 Loading other dangerous articles.
74.533 Truck bodies or trailers on flat cars.

Subpart B — Loading and Storage Chart of Explosives and Other Dangerous Articles

74.538 Loading and storage chart of explosives and other dangerous articles.

Subpart C — Placards on Cars

74.540 "Explosives" placards.
74.541 "Dangerous" placards; "Dangerous-class D poison" placards; or "Caution-Residual phosphorus" placards.
74.542 "Poison Gas" placards.
74.543 Placarding cars; passenger trains.
74.544 Placards not required.
74.545 Commodity name on carloads.
74.546 Placards must be standard.
74.547 Carriers' supply of placards.
74.548 Placarded cars.
74.549 Application of placards.
74.550 Explosives, class A placard.
74.551 Poison Gas placard.
74.552 Dangerous placard.
74.553 Dangerous—class D Poison placard.
74.554 Unauthorized use of placards.
74.555 "Caution-Residual phosphorus" placard.

Subpart D — Unloading from Cars

74.560 Tank car delivery.
74.561 Tank car unloading.
74.562 Removal of placards and car certificates after unloading.
74.563 "Dangerous—Empty" placard.
74.564 Removal and disposition of explosives and other dangerous articles at destination.
74.565 Violations and accidents to be reported.
74.566 Cleaning cars.
74.567 Flammable vapors.

Subpart E — Handling by Carriers by Rail Freight

74.575 Restrictions.
74.576 Intermediate shippers and carriers.
74.577 Shipping days for explosives.
74.578 Flammable vapors.
74.579 Cars containing lading which has been fumigated or treated with flammable liquids, flammable gases, poisonous liquids or solids, or poisonous gases.
74.580 Violations must be corrected.
74.581 Routing shipments.
74.582 Movement to be expedited.
74.583 Examination of shipping order and packages.
74.584 Waybills, switching orders or other billing.
Sec.
74.585 Nonagency shipments.
74.586 Handling explosives and other dangerous articles.
74.587 Lights.
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§ **74.500 Purpose of the regulations in Parts 71-78.** (a) To promote the uniform enforcement of law and to minimize the dangers to life and property incident to the transportation of explosives and other dangerous articles by rail freight carriers engaged in interstate or foreign commerce, Parts 71-78 are prescribed to define these articles for transportation purposes and to state the precautions that must be observed by the carrier in handling them while in transit. It is the duty of each such carrier to make the prescribed regulations effective and to thoroughly instruct employes in relation thereto.

§ **74.501 Acceptable articles.** (a) Explosives, including samples of explosives and explosive articles not exceeding 5 pounds net weight and other dangerous articles may be accepted and transported, provided they are in proper condition and are certified, for transportation by rail, highway, or water. Articles must be loaded, stayed, and handled in transit according to regulations applying to service or services used. Methods of manufacture, packing, and storage, in so far as they affect safety in transportation, must be open to inspection by a duly authorized representative of the initial carrier or by the Bureau of Explosives. Shipments of explosives or other dangerous articles not in proper condition for transportation, or loaded or stayed as required, or certified as to proper packing, marking and description as required in Parts 71-78, must not be accepted for transportation or transported.

§ **74.502 Forbidden explosives.** (a) The acceptance of the following articles for transportation by common carrier by rail freight, is forbidden:

(1) Diazodinitrophenol, dry.

(2) Dynamite, except gelatin dynamite, containing over 60 percent of liquid explosive ingredient.

(3) Dynamite having an unsatisfactory absorbent, or one that permits leakage of a liquid explosive ingredient under any conditions liable to exist during transportation or storage.

(4) Explosive compositions that ignite spontaneously or undergo marked decomposition when subjected for 48 consecutive hours to a temperature of 75°C. (167°F.).

(5) Explosives containing an ammonium salt and a chlorate.

(6) Explosives condemned by the Bureau of Explosives (except properly packaged samples for laboratory examinations).

(7) Explosives not packed, marked, described, and certified, in accordance with Parts 71-78.

(8) New explosives (except samples for laboratory examination) until approved for transportation by the Bureau of Explosives.

(9) Condemned or leaking dynamite must not be repacked and offered for shipment unless the repacking is done by a competent person in the presence of, or with the written consent of, an inspector, or with the written authority of the chief inspector, of the Bureau of Explosives.

(10) Leaking or damaged packages of explosives must not be accepted for transportation or transported by rail. Should any package of high explosives when offered for shipment show excessive dampness or be moldy or show outward signs of any oily stain or other indication that absorption of the liquid part of the explosive is not perfect, or that the amount of the liquid part is greater than the absorbent can carry, the package must be refused in every instance. The shipper must substantiate any claim that a stain is due to contact with material other than the liquid explosive ingredient of an explosive. In case of doubt the package must be rejected.

(11) Firecrackers, flash crackers, or salutes, the explosive contents of which exceed 12 grains each in weight.

(12) Fireworks that combine an explosive and a detonator or blasting cap.

(13) Fireworks containing an ammonium salt and a chlorate.

(14) Fireworks containing yellow or white phosphorus.

(15) Fireworks or fireworks compositions that ignite spontaneously or undergo marked decomposition when subjected for 48 consecutive hours to a temperature of 75°C. (167°F.).

(16) Fireworks properly condemned by the Bureau of Explosives, except properly repacked samples for laboratory examinations.

(17) Toy caps containing more than an average of twenty-five hundredths of a grain of explosive composition per cap.

(18) Toy torpedoes the maximum outside dimension of which exceeds ⅞ inch, or toy torpedoes containing a mixture of potassium chlorate, black antimony and sulfur with an average weight of explosive composition in each torpedo exceeding four grains.

(19) Toy torpedoes containing a cap composed of a mixture of red phosphorus and potassium chlorate exceeding an average of one-half (0.5) grain per cap.

(20) Fulminate of mercury, dry.

(21) Guanyl nitrosamino guanylidene hydrazine, dry.

(22) Lead azide, dry.

(23) Lead styphnate (lead trinitroesorcinate), dry.

(24) Nitroglycerin, liquid.

(25) Nitro mannite, dry.

(26) Nitrosoguanidine, dry.

(27) Pentaerythrite tetranitrate, dry.

(28) Tetrazene (guanyl nitrosamino guanyl tetrazene), dry.

(29) Fireworks containing copper sulfate and a chlorate.

§ 74.503 **"Order-Notify," "C. O. D.," and "Stop-off" shipments.** (a) Except on through bills of lading to a foreign country, shipments of explosives, class A, and blasting caps in any quantity must not be accepted for transportation or transported by carrier by rail freight when consigned "to order notify" or "C. O. D." Shippers must not consign these shipments to themselves at points where they have not a resident representative.

(b) Explosives, class A, must not be accepted for transportation or transported by carrier by rail freight subject to "stop-off" privileges en route for partial loading or unloading.

§ **74.504 Carriers' material and supplies.** (a) Parts 71-78 apply also to shipments of carriers' material and supplies moving by rail.

§ **74.505 Canadian shipments.** (a) Explosives and other dangerous articles as defined in Parts 71-78, which are packed, marked, labeled, and loaded, in conformity with the regulations of the Board of Transport Commissioners for Canada, may be accepted and carried by carriers from point of entry in the United States to their destination in the United States or through the United States en route to a point in Canada.

NOTE 1: Because of the present emergency and until further order of the Commission, compressed gas cylinders 40 inches in length and 8 inches in diameter, charged with not more than 40 pounds of carbon dioxide or when charged with nitrogen not in excess of 2,000 pounds per square inch, and shipped by or to the Canadian Department of National Defense in accordance with Board of Transport Commissioners for Canada Order No. 76253 dated March 10, 1951, may be shipped to destinations in the United States or through the United States to points in Canada.

§ **74.506 Improperly packed or damaged shipments in transportation.** (a) For the protection of the public against fire, explosion, or other, or further hazard with respect to shipments of explosives or other dangerous articles offered for transportation or in transit by any carrier by railroad, such carrier shall make immediate report to the Bureau of Explosives, 30 Vesey Street, New York, N. Y., for handling, any of the following emergency matters coming to their attention:

(1) Instances of packages of explosives or other dangerous articles discovered in transit not properly prepared for transportation in accordance with applicable regulation in Parts 71-78.

(2) Railroad wrecks or accidents involving damage to containers of explosives or other dangerous articles to such a degree as to necessitate repacking of the articles. (See § 74.588.)

(3) Other like emergencies in which any carrier by railroad is or is likely to become involved, or may offer aid at its command.

(b) This section shall in no respect excuse either shipper or carrier by railroad for failure to exercise due care to prevent any departure from any regulation prescribed in Parts 71-78.

§ **74.507 Labels.** (See §§ 73.405 to 73.414 for description of labels.) (a) Carriers must keep on hand an adequate supply of labels. Lost or detached labels must be replaced from information given on revenue or other waybill, manifest, memo or other shipping paper.

(b) The carrier's name and stationery form number may be printed on the labels, in type not larger than 10 point, if placed within the black-line border and in the upper or lower corner of the diamond.

§ **74.508 Violations and accidents to be reported.** (a) Serious violations of Parts 71-78 (such as defective packing, improper staying, or rough treatment of car), and accidents, fires or explosions, and leaking or broken containers occurring in connection with the transportation or storage on carrier's property of explosives or other dangerous articles, must be reported promptly by the rail carrier to the Bureau of Explosives.

(b) The Bureau of Explosives, upon receipt of reports from carriers should promptly report to the shipper full particulars covering all cases of defective packing, improper staying, leaking and broken shipping containers and rough treatment of cars resulting in leakage or damage to shipping containers or staying.

§ **74.509 Quantity limitations.** (a) When quantity limitations are specified in Parts 71-78 by United States liquid measure or by avoirdupois weight it is authorized that quantities measured by the metric system may be substituted, up to but not exceeding 1 gallon for liquid and 10 pounds for solids, on the basis of 1 liter per quart specified and 500 grams per pound specified.

SUBPART A—LOADING, UNLOADING, PLACARDING AND HANDLING CARS; LOADING PACKAGES INTO CARS

§ 74.525 **Loading packages of explosives in cars, selection, preparation, inspection, and certification.** (a) Except as provided in § 71-13 (a) (3) and § 74.526 (b), (n), and (o), explosives, class A, must be loaded in closed cars, certified and placarded "Explosives."

(b) Certified closed cars must be inspected inside and outside, other cars must be inspected as applicable to the type of car, and must conform to the following specifications:

(1) Closed cars of not less than 80,000 pounds capacity, with steel underframes and friction draft gear, must be used when available, except that on narrow-gage and other railroads, explosives may be transported in cars of less than that capacity, provided the available cars of greatest capacity and strength are used for this purpose.

(2) Must be equipped with air brakes and hand brakes in condition for service.

(3) Must have no loose boards or cracks in the roof, sides, or ends, through which sparks may enter, or unprotected decayed spots liable to hold sparks and start a fire.

(4) The roof of the car must be carefully inspected from the outside for decayed spots or broken boards, especially under or near the running board, and such spots must be covered or repaired to prevent their holding fire from sparks. A car with a roof generally decayed, even if tight, must not be used.

(5) The doors must shut so closely that no sparks can get in at the joints, and, when necessary, they must be stripped. The stripping for doors should be on the inside and be fastened to the door frames where it will form a shoulder against which the closed doors are pressed by means of wedges or cleats in door shoes or keepers. The openings under the doors should be similarly closed. The hasp fastenings must be examined with doors closed and fastened, and the doors must be cleated when necessary to prevent doors shifting. When the car is opened for any cause, wedges or cleats must be replaced before car containing explosives is permitted to proceed.

(6) The journal boxes and trucks must be carefully examined and put in such condition as to reduce to a minimum the danger of hotboxes or other failure necessitating the setting out of the car before reaching destination. The lids or covers of journal boxes must be in place.

(7) The car must be carefully swept out before it is loaded. For less-than-carload shipments the space in which the packages are to be loaded must be carefully swept.

(8) Holes in the floor or lining must be repaired and special care taken to have no projecting nails or bolts or exposed pieces of metal which may work loose or produce holes in packages of explosives during transit. Protruding nails in the floor or lining which have worked loose must be drawn, and if necessary for the purpose of fastening the floor or lining, new nails must be driven through other parts thereof.

(9) When packages of explosives are to be loaded over exposed draft bolts or king bolts, these bolts must have pieces of sound wood with beveled ends spiked to the floor over them (or empty wooden boxes of the same character as those used for the explosive may be used for this purpose) to prevent possibility of the bolts causing damage to the package of explosives. Metal floor plates must be completely covered with wood, plywood, or fiber or composition sheets of adequate thickness and strength to prevent contact of the floor plates with the packages of explosives under conditions incident to transportation, except that the covering of metal floor plates is not necessary for carload shipments loaded by the Departments of the Army, Navy, or Air Force of the United States Government provided the explosives are of such nature that they are not liable to leakage of dust, powder, or vapor which might become the cause of an explosion.

(10) Cars equipped with automobile loading devices must not be used unless the loading device is securely attached to the roof of car with fastenings supplementing those already provided and so fixed that it cannot fall.

(11) The carrier must have the car examined by a competent employee to see that it is properly prepared, and must have a "Car Certificate" signed in triplicate upon the prescribed form (see paragraph (c) (2) and (3) of this section) before permitting the car to be loaded.

(12) Except as provided in § 74.584 (h), a car must not be loaded with any explosives, class A, until it shall have been thoroughly inspected by a competent employee of the carrier who shall certify as to its proper condition under this section and shall sign certificate No. 1 prescribed in paragraph (c) (2) and (3) of this section.

(c) After a certified car as prescribed in this section has been furnished by the carrier, the shipper or his authorized employee must, before commencing the loading of any such car, inspect the interior thereof and after loading, certify to the proper condition as specified in paragraph (b) of this section by signing certificate No. 2 of the car certificate prescribed by subparagraphs (2) and (3) of this paragraph.

(1) For all shipments loaded by the shipper, a competent employee of the carrier must inspect the finished load and certify to its compliance with this part before the car shall be accepted for transportation; and certificate No. 2 as prescribed by subparagraphs (2) and (3) of this paragraph shall be signed before the car is permitted to go forward. When a car is loaded by the carrier, certificate No. 2 must be signed only by the representative of the carrier.

(2) The certificates as prescribed in subparagrhp (3) of this paragraph must not be signed by the carrier's or shipper's representative unless the condition of any car covered thereby meets the requirements of this part.

(3) Car Certificate. The following certificate, printed on strong tag board measuring 7 by 7 inches, or 6 by 8 inches, must be duly executed in triplicate by the carrier, and by the shipper, if he loads the shipment; the original must be filed by the carrier at the forwarding station on a separate file; and the other two must be attached, one to each outer side of car to the fixed placard board or to the side of wooden car between car initials and the car door, or as otherwise provided. (See § 74.549.)

....................................Railroad

CAR CERTIFICATE

No. 1 .... Station, ..., 19.....

I hereby certify that I have this day personally examined .... car No. ....; and that car structure has no loose boards, holes or cracks, or unprotected decayed spots liable to hold sparks and start a fire; that the kingbolts and draft bolts are properly protected and that there are no uncovered pieces of metal or nails projecting from the car which might cause injury to packages or containers of explosives; also that the floor is in good condition and has this day been cleanly swept before the car was loaded; that I have examined all the axle boxes and that they are properly covered, packed, and oiled, and that the air brakes and hand brakes are in condition for service.

....

Railway employee inspecting car

No. 2 .... Station, ..., 19......

I hereby certify that I have this day personally examined the above car; that the floor is in good condition and has been cleanly swept and that car structure has no loose boards, holes, cracks, or unprotected decayed spots liable to hold sparks and start a fire; that the kingbolts and draft bolts are protected, and that there are no uncovered pieces of metal or nails projecting from the car which might cause injury to packages or containers of explosives; that the explosives in or on this car have been loaded and braced and the car has been placarded, according to the regulations for the transportation of explosives prescribed by the Interstate Commerce Commission; that the doors of car so equipped fit or have been stripped so that sparks cannot get in at the joints or bottom.

....
Shipper.

....
Railway employee inspecting
loading and bracing.

NOTE 1: Both certificates must be signed; certificate No. 1 by the representative of the carrier. For all shipments loaded by the shipper he or his authorized agent must sign certificate No. 2, and the representative of the carrier must certify as to loading, bracing and general conditions. When the car is not loaded by the shipper, certificate No. 2 must be signed only by the representative of the carrier. A shipper must decline to use a car not in proper condition.

(4) Car certificates remaining on hand and which were authorized by regulations in effect prior to February 16, 1957, may be used for closed car inspections until stocks are exhausted.

§ **74.526 Loading explosives into cars.** (a) Boxes or other containers of class A explosives named in §§ 73.53 to 73.87 when marked "This Side Up" must be loaded accordingly. Boxes may be loaded crosswise or lengthwise of the car, but not so that the ends of wooden boxes will bear against the sides of fiberboard boxes, or so that the end of any box will cause a high pressure on a small area of another box.

(b) Shipments of explosive bombs, unfuzed explosive projectiles, and jet thrust units when not packed in wooden boxes, and large metal containers of incendiary bombs weighing 500 pounds or more, each, may be loaded in stock cars or in gondola cars (flat bottom) when adequately braced. Wooden boxed bombs or jet thrust units which, due to size, cannot be loaded in closed cars may be loaded in open top cars but must be protected against accidental ignition.

(c) Boxes of high explosives, low explosives, or black powder, packed in long cartridges, bags or siftproof liners, and containing no liquid explosive ingredient, may be loaded on their sides or ends, but not so that the end of a box will cause a high pressure on a small area of another box.

(d) Explosives for which a certified and placarded car is prescribed (see § 74.525 (a) of this part) must not be loaded higher than the permanent car lining unless additional lining is provided as high as the lading.

(e) When the lading of a car consists of or includes any explosives, the weight of the lading should be distributed so that it will be equalized on each side of the car and over the trucks.

(f) Explosives packed in metal kegs, except when boxed, must be loaded on their sides with ends towards ends of the car; packages of explosives must not be placed in the space opposite the doors unless the doorways are boarded on the inside as high as the lading. (This does not apply to palletized packages provided they are braced so that they cannot fall or slide into the doorways during transit.)

(g) Wooden or fiber kegs, barrels, or drums, may be loaded on their sides or ends, as will best suit the conditions.

(h) Packages containing any of the explosives for the transportation of which a certified and placarded car is prescribed (see § 74.525 of this part) and blasting caps or electric blasting caps in any quantity, must be stayed (blocked and braced) by the one who loads the car, so as to prevent change of position by the ordinary shocks incident to transportation. Special care must be used to prevent such packages from falling to the floor or from having anything fall on them or slide against them during transit. (See Note 1.)

NOTE 1: For recommended methods of blocking and bracing, see Bureau of Explosives' Pamphlets 6 and 6A.

(i) To prevent delays to local freight trains, when there are shipments of explosives for different destinations loaded in a "peddler car" or "way car," the shipments for each destination must be stayed separately.

(j) Forwarding and transfer stations for explosives must be provided with the necessary materials for staying.

(k) Shippers must furnish the material for staying packages of explosives loaded by them.

(l) Explosives, class A, must not be loaded, transported, or stored in cars equipped with any type of lighted heater or open-flame device, or electric devices having exposed heating coils, or in cars equipped with any apparatus or mechanism utilizing an internal combustion engine in its operation.

(m) Blasting caps or electric blasting caps in quantity not exceeding 1,000 caps may be loaded in any closed car which is in good condition, without car certificates or placards.

(n) Container cars or portable metal containers on flat cars or gondola cars (drop-bottom cars not authorized), when properly loaded, blocked, and braced to prevent change of position under conditions incident to normal transportation handling, may be used for any class A explosive except black powder packed in metal containers.

(1) Portable metal containers must be of such design and so braced that there will be no evidence of failure of the container or the bracing when subjected to impact of at least 8 miles per hour. Efficiency shall be determined by actual test, using dummy loads equal in weight and general character to material to be shipped.

(2) Container cars or cars which are loaded with portable metal containers must be placarded with the "Explosives" placards as prescribed in § 74.550 and properly executed car certificates as required by § 74.525.

(3) Lading shall be so loaded, blocked, and braced within the container that it will not change position under impact of at least 8 miles per hour.

(o) Explosives, class A, may be loaded and transported in tight, closed truck bodies or trailers, on flat cars provided all of the following requirements are fulfilled:

(1) Truck body or trailer must meet the requirements of Part 77 of these regulations, applicable to shipments of explosives by motor vehicle.

(2) Truck body or trailer shall be so loaded and braced on the car that it will not change position or show evidence of failure or impending failure of the bracing or blocking under impact of at least 8 miles per hour. Efficiency shall be determined by actual test, using dummy loads equal in weight and general character to material to be shipped.

(3) Lading shall be so loaded, blocked, and braced within the truck body or trailer that it will not change position under impact of at least 8 miles per hour.

(4) Cars or truck bodies or trailers on cars must be placarded with the "Explosives" placards as prescribed in § 74.550 and properly executed car certificates as required by § 74.525.

§ **74.527 Forbidden mixed loading and storage.** (a) Explosives, class A, and initiating or priming explosives must not be transported in the same car with, nor be stored on railway property near, any of the dangerous articles other than explosives for which red, yellow, green, white (acid or corrosive liquid) or radioactive material labels are prescribed in Parts 71-78, nor with charged electric storage batteries.

(b) Explosives must not be loaded together nor with other dangerous articles, except as provided in the loading and storage chart (see § 74.538). See § 74.584 (h) for loading shipments of explosives or any other material in a placarded and certified car containing a shipment of class A explosives.

§ **74.528 Protect explosives from injury.** (a) In a car containing explosives, the explosives and all other freight must be so loaded, and if necessary so braced and stayed, as to prevent injury to packages of explosives during transit. When practicable, explosives should be loaded so as to avoid transfer at stations.

§ 74.529 **Cars for class B explosives.** (a) Explosives, class B, must not be loaded, transported, or stored in cars equipped with any type of lighted heater or open-flame device, or in cars equipped with any apparatus or mechanism utilizing an internal combustion engine in its operation.

(b) Shipments of class B explosives must be loaded in a closed car or container car which is in good condition, into which sparks cannot enter, and with roof not in danger of taking fire through unprotected decayed wood. These cars do not require the car certificate but must have attached to both sides and both ends the "DANGEROUS" placard prescribed by § 74.552, and the doors if not tight must be stripped to prevent entrance of sparks.

(c) Explosives, class B, may be carried in tight, closed truck bodies or trailers on flat cars provided such truck bodies or trailers are not equipped with fuel tanks, lighted heaters, or any automatic heating or refrigerating apparatus. Packages of explosives shall be so braced and stayed as to prevent their movement and so as to prevent injury to them due to movement of other freight during transit. Ends, side walls, or doors of truck bodies or trailers shall not be relied upon to prevent the shifting of heavy loads unless adequately designed. "Dangerous" placards prescribed by § 74.552 must be securely attached to the car or truck body or trailer so as to be visible from both sides and ends of the car.

§ 74.530 **Cars for class C, explosives.** (a) Explosives, class C, may be loaded into any closed car in good condition. With the exception of blasting caps and electric blasting caps, explosives, class C, may be loaded into any container car in good condition. No placards or car certificates are required.

(b) Explosives, class C, may be carried in tight, closed truck bodies or trailers on flat cars provided such truck bodies or trailers are not equipped with fuel tanks, lighted heaters, or any automatic heating or refrigerating apparatus. Ends, side walls, or doors of truck bodies or trailers shall not be relied upon to prevent the shifting of heavy loads unless adequately designed.

§ 74.531 **Lights.** (a) When necessary to use lights while handling explosives, it is recommended that where practicable incandescent electric lights be provided.

§ 74.532 **Loading other dangerous articles.** (a) Shipments must be properly loaded in closed cars, container cars, or in tight closed truck bodies or trailers on flat cars, except as otherwise provided in Parts 71-78 and cars placarded as prescribed, when accepted by carriers. Ends, side walls, or doors of truck bodies or trailers shall not be relied upon to prevent the shifting of heavy loads unless adequately designed.

(1) Shippers must furnish the material for staying packages of other dangerous articles loaded by them.

(b) Flammable liquids (red label) and flammable compressed gases (red gas label) must not be loaded, transported, or stored in cars equipped with any type of lighted heater or open-flame device, or in cars equipped with any apparatus or mechanism utilizing an internal combustion engine in its operation.

(1) Flammable liquids (red label) and flammable gases (red label) must not be loaded in truck bodies or trailers equipped with lighted heaters or any automatic heating or refrigerating apparatus when such truck bodies or trailers are loaded on flat cars.

(c) Packages protected by labels or exempted from labels by § 73.402 (c) must be so loaded that they cannot fall and in such manner that other packages cannot fall onto or slide against them. Packages bearing marking "This Side Up" or "This End Up" must be so loaded. Dangerous articles for which red, yellow, green, or white (acid, alkaline caustic liquid, or corrosive liquid) labels are prescribed herein must not be loaded in the same car with explosives named in §§ 73.53 to 73.87. (See loading and storage chart, § 74.538.) Packages protected by yellow labels must not be loaded in the same end of a car with packages protected by "Acid," "Alkaline Caustic Liquid," or "Corrosive Liquid" labels, except that shippers loading carload shipments may load such articles together when it is known that the mixture of contents would not cause a dangerous evolution of heat or gas.

(d) Metal barrels or drums containing flammable liquids may be loaded on steel gondola or flat cars or into stock cars, but must not be loaded into hopper bottom cars.

NOTE 1: See Bureau of Explosives' Pamphlet No. 6 for recommended methods of blocking and bracing these articles in cars. See loading and storage chart (§ 74.538 of this part) before loading labeled articles together or with explosives named in §§ 73.53 to 73.87.

(e) Empty cylinders, barrels, kegs, or drums, previously used for the shipment of any dangerous article, as defined in Part 73, must have all openings including removable heads, filling and vent holes properly closed before being offered for transportation. Small quantities of the material with which containers were loaded may remain in "empty" containers and when the vapors remaining therein are unstable, it is permissible to add sufficient inert gas to render the vapors stable.

(1) They may be loaded in open or stock cars when desired. Cars should not be placarded but lighted open-flame lanterns or other open-flame lights should be kept away.

(f) Carboys previously used for the shipment of corrosive liquids when phesented to carriers for transportation in carload or less-than-carload shipments as "empty" carboys, must be thoroughly (completely) drained. Whenever practicable they should not be loaded with valuable or perishable freight.

(g) Matches: Carload lots of strike-anywhere (friction) matches must be loaded as compactly as possible to avoid motion within the car, especially lengthwise of the car. Protruding nails, metal band anchors or other projections on sidewalls, ends, door posts, studding, or car floors liable to puncture packages must be removed or adequately covered to prevent damage to containers of matches. Car doorways should be boarded on the inside to keep packages from contact with the doors, and the inside lining of the car should be supplemented when necessary by strips nailed to the car and close enough together to keep the boxes from being jammed against the studding and broken by high pressures on small areas. The strongest dimension of the box should be loaded lengthwise of the car.

(1) When packages are loaded over or near exposed draft bolts or kingbolts, the bolts should be covered by boards not less than 1 inch thick or by empty wooden boxes of proper size, and the ends of these boards should be beveled to prevent the end of a box resting against the end of the board and being crushed by it. Partial layers of boxes should be interlocked with the lower layers. The cars used should be made secure against the entrance of sparks or rain and should be the strongest cars available. Under no condition should any car be loaded with more than 48,000 pounds gross weight of strike-anywhere matches.

(2) Carload lots of strike-anywhere matches handled subject to stop-off privileges must be loaded in accordance with paragraph (g) and (g) (1) of this section and when necessary the load must be rearranged and/or blocked and braced by each consignee before forwarding.

(3) Less-than-carload lots of "strike-anywhere" matches should be carefully loaded so that they cannot fall and so that other packages of freight cannot fall on or injure them. Whenever practicable the packages of matches should be placed to facilitate ready removal in case of fire. A smoking box of matches should not be broken open; the fire will cease of itself if air can be kept from it.

(4) Carload or less-than-carload lots of "strike-anywhere matches which have been damaged by fire, or by water in extinguishing a fire, in transit or on carrier's property, must be reloaded in properly prepared cars, and braced or blocked before being forwarded to destination, to freight claim department or claim adjusters, or to original shipper or other parties for salvage. Great care should be taken to examine and repair damaged outside packages before reloading into car. All loose matches should first be destroyed. Individual interior boxes and paper-wrapped cartons or packages, should then be carefully placed in tight outside packages complying, as nearly as circumstances will permit, with container specifications; but under no condition shall the outside package be of less strength than required by specification 15A or 12C, nor of greater capacity than authorized. Charred

cases must not be used. Boards used in repairing wooden cases must be so nailed that they will not allow any interior boxes, cartons, or packages to fall out. In the event that the individual boxes or paper-wrapped packages do not fit snugly in the outside package, the vacant spaces should be filled tightly with dry and clean cotton waste, or elastic wads of dry newspapers or dry waste paper.

(h) Corrosive liquids: Carboys of acids or other corrosive liquids must not be loaded into container cars. They must be so blocked, braced or stayed that they cannot change position during transit when being handled with reasonable care. Carboys of nitric acid must not be loaded into box cars or in truck bodies or trailers on flat cars more than two tiers high, except that completely boxed carboys, specification 1D, may be loaded three tiers high. Car doors may be cleated in an open position if desired. Flat or stock cars may be used for loading carboys of acids.

(1) When less-than-carload shipments are loaded with other freight, the carboys must be placed near the doorway and must have wooden strips not less than 2 inches in height nailed to the car floor about 8 inches from the bracing. These strips must be arranged so that the liquid from a broken carboy will drain toward the doorway and outside the car. The space between the strips and the floor braces or blocking used for staying the carboy boxes must be covered with at least 1 inch thickness of clean and dry sand or earth, not sawdust or other combustible material.

(2) Nitric acid, when loaded with other acids or other corrosive liquids in carboys, must be separated from the other carboys. A 2 by 6 inch plank, set on edge, should be nailed across the car floor at least 12 inches from the nitric acid carboys and the space between the plank and the carboys of nitric acid should be filled with sand, sifted ashes, or other incombustible absorbent material.

(3) Electric storage batteries (wet) for shipment must be completely protected so that short circuits will be prevented and must not be loaded or stored with explosives.

(4) Shipments of electric storage batteries (wet), and electrolyte packed as required by § 73.258, must be so blocked and braced that they cannot change position during transit when cars are handled with reasonable care; and must be so loaded that other freight cannot fall onto or slide against them. They may be loaded on gondola or flat cars, but must not be loaded into hopper bottom cars.

(i) Compressed gases in cylinders: Cylinders containing compressed gases must be loaded on their sides except when packed in boxes or crates, or when placed in suitable permanent racks in cars, or when securely braced.

(1) Cylinders containing compressed gases may be loaded into steel gondola or flat cars or into stock cars, but must not be loaded into hopper bottom cars.

(j) Radioactive ores, residues, and similar material: Shipments of radioactive ores, residues, or similar material as provided in § 73.392, must be so loaded as to avoid spillage and scattering of loose material.

(1) The amount of radioactive material loaded in a car must be limited as provided in § 73.392.

(2) No persons shall remain in a car containing radioactive material unnecessarily and the shipper must furnish the carrier with such information and equipment as is necessary for the protection of the carrier's employees.

(3) Any loose radioactive material must be removed from the car and placed in a closed container in a segregated location and held for instructions from the shipper or the Bureau of Explosives.

(k) Nitrates listed in § 73.182 (b) must be loaded in clean closed cars which shall be free of loose boards, cracks, holes, or exposed decayed spots. Interior of cars must be swept clean and be free of any projections capable of injuring bags when so packaged. Doors of cars must have tight closures. Journals and boxes must be in good condition. Ammonium nitrate, ammonium nitrate (organic coating), ammonium nitrate fertilizer, containing 90 percent or more ammonium nitrate with no organic coating, and guanidine nitrate must be loaded in all wood box cars, or wooden box cars with steel roofs, or steel box cars with wooden floors and must not be loaded in all metal cars (see also § 74.451 (a) (1)).

(l) Poison gas; class A, by rail freight. Poison gases, class A, may be shipped by, for, or to, the Departments of the Army, Navy, or Air Force of the United States Government, when loaded and handled as follows:

(1) In metal drums, specification ICC 5A or WD 5A[1], in box cars, gondola cars, or stock cars (flat bottom) in carload lots.

[1] War Department specification container.

(2) In tanks, specification ICC 106A, mounted on or secured to multi-unit cars or gondola cars (flat bottom) in carload lots only

(3) In bombs, in box cars or gondola cars (flat bottom) in carload lots only.

(4) In projectiles or ammunition for cannon with gas filled projectiles in box cars in carload or less-than-carload lots.

(5) Gas handlers. Each shipment of one or more carloads, as described in subparagraph (1) of this paragraph, shall be accompanied by a crew of qualified gas handlers, supplied with equipment to handle leaks or other container failure, which will permit the escape of gas. Gas handlers will remain with the shipment during the entire time that it is in the custody of the carrier. Gas handlers will, in the event of leakage or escape of gas, make repairs and perform decontamination, if necessary. If they need assistance they will advise the carrier's representative as to the nearest Chemical Warfare Service Depot and aid required.

(6) Loading and bracing in cars. Drums must be loaded in cars having level floors. Cars equipped with metal corrugated ends or cars having bowed ends must be supplied with end wall bulkheads constructed in accordance with requirements for center gates. (See Sketch 1, Bureau of Explosives' Pamphlet No. 6.)

(7) Drums must be loaded not more than one tier (layer) high and with filling holes up. They must be loaded as closely together as possible both crosswise and lengthwise and so blocked and braced as to maintain their relative positions during transit.

(8) Drums with filling holes in heads must be loaded on their bottoms. They may be loaded in rows, lengthwise of the car and any space between the sides of car and the nearest row of drums must be "filled in" with wooden boards or lumber nailed to sides of car sufficient in length and width to contact both hoops of drums, or, drums may be loaded across car in staggered stacks of which the number of drums in alternate stacks is reduced by one drum. All drums in stacks following the first stack loaded in end of car must be placed tightly into the angle of space formed by the sidewalls of the drum in the preceding stack. Any space between the sides of car and the drums in stacks having the greater number of drums must be "filled in" with wooden boards or lumber nailed to sides of car sufficient in length and width to contact both hoops of drums.

(9) Drums with filling holes in sides must be loaded on their sides with filling holes up. They must be loaded lengthwise of the car in rows and any space between sides of car and the nearest row of drums must be "filled in" with wooden boards or lumber nailed to sides of car sufficient in length and width to contact both hoops of drums.

(10) Drums must be loaded in box car from ends of car toward space between car doors, and there braced by center gates and wedges. (See Sketch 1, Bureau of Explosives' Pamphlet No. 6.)

(11) Doorways of box cars must be protected by one of the methods prescribed in Sketch 1, Bureau of Explosives' Pamphlet No. 6A.

(12) Tanks must be securely mounted on cars especially provided for them or on gondola cars prepared with substantial wooden frames and blocks.

(13) Bombs, projectiles, and cannon ammunition must be loaded, blocked and braced as shown in Bureau of

Explosives' Pamphlet 6A. When shipments are loaded in gondola cars they must be securely blocked and braced and not loaded higher than the sides of the car.

§ 74.533 **Truck bodies or trailers on flat cars.** (a) Truck bodies or trailers containing explosives, class B, explosives, class C, or other dangerous articles as provided in Parts 71-78 must be of such design and loaded so that they will not rupture or become permanently distorted under conditions normally incident to transportation and must be so braced and stayed on the flat car that they cannot change position during transit. Packages of explosives and dangerous articles contained therein must be loaded and braced as provided by §§ 74.529, 74.530, and 74.532. Placards must be applied when prescribed by §§ 74.541 and 74.542.

(b) Truck bodies or trailers equipped with automatic heating or refrigerating equipment employing any fuel or article classed as a dangerous article in Parts 71-78 may be loaded and transported on flat cars if such equipment is of a type approved by the Bureau of Explosives. They must be so braced and stayed on the flat car that they cannot change position during transit.

(c) A truck body or trailer on which is mounted any cargo tank containing any dangerous article shall not be accepted for transportation or transported except under conditions approved by the Bureau of Explosives.

SUBPART B—LOADING AND STORAGE CHART OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES

§ 74.538 Loading and storage chart of explosives and other dangerous articles. (a) Explosives or other dangerous articles must not be loaded, transported, or stored together, except as provided in the Loading and Storage Chart of Explosives and Other Dangerous Articles shown in this section.

The following table shows the explosives and other dangerous articles which must not be loaded or stored together. The letter X at an intersection of horizontal and vertical columns shows that these articles must not be loaded or stored together, for example: detonating fuses class A, with or without radioactive components g horizontal column must not be loaded or stored with high explosives or propellant explosives, class A b vertical column.		Low explosives or black powder	High explosives or propellant explosives, class A	Initiating or priming explosives, wet: Diazodinitrophenol, fulminate of mercury, guanyl nitrosamino guanylidene hydrazine, lead azide, lead styphnate, nitro mannite, nitrosoguanidine, pentaerythrite tetranitrate, tetrazene	Blasting caps, with or without safety fuse (including electric blasting caps), detonating primers	Ammunition for cannon with explosive projectiles, gas projectiles, smoke projectiles, incendiary projectiles, illuminating projectiles or shell, ammunition for small arms with explosive bullets, or ammunition for small arms with explosive projectiles, or rocket ammunition with explosive projectiles, gas projectiles, smoke projectiles, incendiary projectiles, illuminating projectiles; and boosters (explosive), bursters (explosive), or supplementary charges (explosive) without detonators, [c], [d]	Explosive projectiles, bombs, torpedoes, or mines, rifle or hand grenades (explosive), jet thrust units (jato), explosive, class A, or igniters, jet thrust (jato), explosive, class A [e]	Detonating fuses, class A, with or without radioactive components	Ammunition for cannon with empty, inert-loaded or solid projectiles, or without projectiles, or rocket ammunition with empty projectiles, inert-loaded or solid projectiles or without projectiles	Propellant explosives, class B, jet thrust units (jato), class B, igniters, jet thrust (jato), class B, or starter cartridges, jet engine, class B	Fireworks, special or railway torpedoes	Small arms ammunition	Primers for cannon or small arms, empty cartridge bags—black powder igniters, empty cartridge cases, primed, empty grenades, primed, combination primers or percussion caps, toy caps, explosive cable cutters, explosive rivets	Percussion fuzes, tracer fuzes or tracers	Time, combination or detonating fuzes, class C	Cordeau detonant fuse, safety squibs, fuse lighters, fuse igniters, delay electric igniters, electric squibs, instantaneous fuse or igniter cord	Fireworks, common, highway fusees or railway fusees	Flammable liquids or compressed flammable gases, red label	Flammable solids or oxidizing materials, yellow label	Acids or corrosive liquids, white label	Compressed nonflammable gases, green label	Poisonous gases or liquids, in cylinders, projectiles or bombs, poison gas label	Radioactive materials (class D poisons)
		a	b	c	d	e	f	g	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLASS A EXPLOSIVES Low explosives or black powder	a			X							X						X	X	X	X	X	X	X
High explosives or propellant explosives, class A	b			X	X			X			X						X	X	[c] X	X	X	X	X
Initiating or priming explosives, wet: Diazodinitrophenol, fulminate of mercury, guanyl nitrosamino guanylidene hydrazine, lead azide, lead styphnate, nitro mannite, nitrosoguanidine, pentaerythrite tetranitrate, tetrazene	c	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Blasting caps, with or without safety fuse (including electric blasting caps), detonating primers	d		X	X		X	X				[a] X						[a] X	[a] X	[a][c] X	[a] X	[a] X	X	X
Ammunition for cannon with explosive projectiles, gas projectiles, smoke projectiles, incendiary projectiles, illuminating projectiles or shell, ammunition for small arms with explosive bullets, or ammunition for small arms with explosive projectiles, or rocket ammunition with explosive projectiles, gas projectiles, smoke projectiles, incendiary projectiles, illuminating projectiles; and boosters (explosive), bursters (explosive), or supplementary charges (explosive) without detonators, [c], [d]	e			X	X			X			X						X	X	X	X	X	X	X
Explosive projectiles, bombs, torpedoes, or mines, rifle or hand grenades (explosive), jet thrust units (jato), explosive, class A, or igniters, jet thrust (jato), explosive, class A [e]	f			X	X			X			X						X	X	X	X	X	X	X
Detonating fuses, class A, with or without radioactive components	g		X	X		X	X				X						X	X	X	X	X	X	X

CLASS B EXPLOSIVES																							
Ammunition for cannon with empty, inert-loaded or solid projectiles, or without projectiles, or rocket ammunition with empty projectiles, inert-loaded or solid projectiles or without projectiles	1	......	......	X	.....	......	......	.....	......	......	......	......	......	......	......	......	......	......	......	[b] X	......	X	......
Propellant explosives, class B, jet thrust units (jato), class B, igniters, jet thrust (jato), class B, or starter cartridges, jet engine, class B	2	......	......	X	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	[b] X	......	X	......
Fireworks, special, or railway torpedoes	3	X	X	X	[a] X	X	X	X	......	......	......	......	......	......	......	......	......	......	......	......	......	X	......
CLASS C EXPLOSIVES																							
Small arms ammunition	4	......	......	X	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Primers for cannon or small arms, empty cartridge bags—black powder igniters, empty cartridge cases, primed, empty grenades, primed, combination primers or percussion caps, toy caps, explosive cable cutters, explosive rivets	5	......	......	X	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Percussion fuzes, tracer fuzes or tracers.	6	......	......	X	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Time, combination or detonating fuzes, class C	7	......	......	X	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Cordeau detonant fuse, safety squibs, fuse lighters, fuse igniters, delay electric igniters, electric squibs, instantaneous fuse or igniter cord	8	......	......	X	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Fireworks, common, highway fusees or railway fusees	9	X	X	X	[a] X	X	X	X	......	......	......	......	......	......	......	......		......	......	......	......	X	......
OTHER DANGEROUS ARTICLES																							
Flammable liquids or compressed flammable gases, red label	10	X	X	X	[a] X	X	X	X	......	......	......	......	......	......	......	......	......	......	......	......	......	X	......
Flammable solids or oxidizing materials, yellow label	11	X	[c] X	X	[a] [c] X	X	X	X	......	......	......	......	......	......	......	......	......	......	......	[b] X	......	X	......
Acids or corrosive liquids, white label	12	X	X	X	[a] X	X	X	X	[b] X	[b] X	......	......	......	......	......	......	......	......	[b] X	......	......	X	......
Compressed nonflammable gases, green label	13	X	X	X	[a] X	X	X	X	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Poisonous gases or liquids, in cylinders, projectiles or bombs, poison gas label	14	X	X	X	X	X	X	X	X	X	X	......	......	......	......	......	X	X	X	X	......	......	......
Radioactive materials (class D poisons)	15	X	X	X	X	X	X	X	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......

[a] Blasting caps or electric blasting caps in quantities not exceeding 1,000 caps may also be loaded and transported with articles named in vertical and horizontal columns 3, 9, 10, 11, 12 and 13. Loading and transportation of blasting caps or electric blasting caps in any quantity with articles named in vertical or horizontal columns b, c, e or f is prohibited.

[b] Unless loaded in opposite ends of car, acids or other corrosive liquids, white label, must not be loaded with yellow label articles, ammunition for cannon with or without projectiles or propellant explosives, except that shippers loading carload shipments of white label and yellow label articles may load such articles together when it is known that the mixture of contents would not cause a dangerous evolution of heat or gas.

[c] Explosives, class A, and explosives, class B, must not be loaded or stored with chemical ammunition containing incendiary charges or white phosphorus either with or without bursting charges. Chemical ammunition of the same classification containing incendiary charges or white phosphorus may be loaded and stored together.

[d] Bursters (explosive), boosters (explosive), or supplementary charges (explosive) without detonators when shipped by, to or for the Departments of the Army, Navy, and Air Force of the United States Government may be loaded with any of the articles named except those in columns c, d, 3, 9, 10, 11, 12, 13, 14, and 15.

[e] Does not include nitro carbo nitrate which may be loaded, transported or stored with high explosives or with blasting caps or electric blasting caps, and detonating primers.

NOTE 1: Charged electric storage batteries must not be loaded in the same car nor stored with any class A explosive.

NOTE 2: Cyanides or cyanide mixtures must not be loaded or stored with acids or corrosive liquids.

NOTE 3: Gas identification sets may be loaded and transported with all articles named except those in column c.

NOTE 4: Nitric acid, when loaded in the same car with other acids or other corrosive liquids in carboys, must be separated from the other carboys. A 2 by 6 inch plank, set on edge, should be nailed across the car floor at least 12 inches from the nitric acid carboys, and the space between the plank and the carboys of nitric acid should be filled with sand, sifted ashes, or other incombustible absorbent material.

SUBPART C—PLACARDS ON CARS

§ 74.540 "Explosives" placards. (a) Explosives placards as prescribed in § 74.550 must be applied to certified cars containing explosives, class A, specified in §§ 73.53 to 73.87. Placards must show in the spaces provided station name and date.

NOTE 1: For cars requiring the poison gas placard see § 74.542.

§ 74.541 "Dangerous" placards; "Dangerous-class D poison" placards; or "Caution-Residual phosphorus" placards. (a) "DANGEROUS" placard, as prescribed by § 74.552 must be applied to cars, and container cars, as follows:

(1) Cars containing one or more packages bearing red, yellow, white acid, or corrosive liquid caution labels, or white "poison" labels, as prescribed by §§ 73.405 to 73.408 and 73.409 (a) (2), or without labels as authorized in § 73.402 (c).

(2) Cars containing flammable solids, oxidizing materials or poisonous solids, class B, in bulk.

(3) Tank cars containing flammable liquids, flammable solids or oxidizing materials, acids or corrosive liquids, poisonous liquids or solids, class B, compressed flammable gases, compressed nonflammable gases.

(4) Cars containing shipments of explosives, class B.

NOTE 1: For cars also requiring the poison gas placard see § 74.542.

(5) When explosives, class A, are loaded in the same car with explosives, class B, or poisonous solids or liquids, class B, only the "Explosives" placard is required.

(b) "Dangerous—Class D poison" placards, as prescribed in § 74.553, must be applied to cars containing shipments of class D poisons as provided in §§ 73.391 and 73.392.

(c) "Caution-Residual phosphorus" placard, as prescribed in § 74.555, must be applied to tank cars which last contained shipments of white or yellow phosphorus and which are required to be filled with water before tank car is offered for return movement as provided in § 73.190 (a) (3).

§ 74.542 "Poison gas" placards. (a) "Poison gas" placards as prescribed by § 74.551 of this part must be applied to cars as follows:

(1) Cars containing one or more packages or articles bearing the "Poison gas" label.

(2) Cars containing ammunition for cannon with toxic gas projectiles, or projectiles, bombs, or other containers loaded with toxic gas requiring the "Poison gas" label.

NOTE 1: The poison gas placard must be applied to cars in addition to any other placards required.

§ 74.543 Placarding care; passenger trains. (a) When a freight, baggage, or express car containing freight shipments of explosives, class B, or freight shipments of dangerous articles other than explosives requiring labels as prescribed by Part 73 (not including class A poison gases or liquids), is hauled in a passenger train and such car or cars are not occupied by an employee of the carrier, proper placards must be applied to the car as required by this part.

§ 74.544 Placards not required. (a) Placards are not required for:

(1) Cars containing explosives, class C.

(2) Cars, other than tank cars, containing nonflammable compressed gas (green label).

(3) Cars containing class C poisons (tear gas label).

(4) Cars loaded with electric storage batteries containing electrolyte or corrosive battery fluid in carload lots.

§ 74.545 Commodity name on carloads. (a) Placards for carloads of class B explosives and other dangerous articles must show thereon, in the space provided, the proper name of the commodity as prescribed by § 72.5, or the commodity name must be shown on tag board cards measuring approximately 5 by 8 inches securely attached to each side of the car.

§ 74.546 Placards must be standard. (a) Placards must conform to standards as prescribed. Samples will be furnished by the Bureau of Explosives on request.

(b) Tag-board placards must be printed on strong tagboard of quality and strength not less than that designated commercially as 100 percent sulphate, weighing 125 pounds per ream, of sheets 24 x 36 inches, and having a resistance of not less than 60 pounds per square inch Mullen test.

(c) Paper placards must be printed on strong white paper.

(d) Placards or car cards which by their shape, coloring, or printing may be readily confused with the standard placards prescribed in this part must not be used.

(e) Carrier's or shipper's name and stationery form number may be printed on placards in type not larger than 10 point, but must be printed thereon separate from any placard wording.

(f) When the tag board placards bear wording prescribed in § 74.552 (a) of this part, and provided the wording prescribed by § 74.563 (e) of this part appears on the reverse side thereof, the words "removed or" may be omitted or the word "removed" changed to "reversed," as the case may be.

(g) Placards remaining on hand and which were authorized by regulations in effect on December 31, 1950, may be used until present stocks are exhausted.

§ 74.547 Carriers supply of placards. (a) Carriers must keep on hand an adequate supply of all necessary placards for placarding cars loaded by them and for the replacement of missing placards on loaded cars while in transit.

§ 74.548 Placarded cars. (a) Shippers must have applied placards to cars loaded by them when cars are acceptable for transportation. (See § 74.549 of this part for method of application.)

§ 74.549 Application of placards. (a) Placards must be securely applied one to each end and each side of car, as follows:

(1) By tacking tag-board placards to each end and each side of cars, or to placard boards of suitable size provided for the purpose.

(2) Placards applied to the sides of closed or open top cars containing explosives or other dangerous articles must be attached to the fixed placard board or to the side of the wooden car between car initials and number and the car door.

(3) Tacks when used must have heads at least ¼ inch across. At least 5 tacks must be used, one at each corner and one in the center of the placard, or when stapling devices are used the staples should be made of flat metal not less than 19 gauge, and the space between the legs of the staples should be at least ⅜ inch and length of staples not less than ¼ inch. At least 9 staples must be used, one at each corner, one along edge between each corner, and one in center. Tacks, nails, staples, or other devices used in previous application of placards must be removed when their presence interferes with proper application of placards.

(4) By insertion of tag-board placards in suitable placard holders affixed to cars.

(5) Paper placards must be securely pasted to metal or other smooth surfaces. Metal placard boards must be used when provided for the purpose. Grease or other substances which interfere with secure application must be removed from surfaces before pasting on placards.

(b) Placards applied to cards must have the printing in horizontal position.

(c) "Explosives" placards and car certificates must be placed alongside of each other.

NOTE 1: Because of the present emergency and until further order of the Commission, gondola cars used for the shipment of bombs or poison gas, may be placarded on both sides and both ends of car.

(d) Placards applied to sides of tank cars must be placed as near the middle as possible. Side placard boards applied to tank cars near end of tank may be used until replaced by boards located near middle of tank, in accordance with requirements effective November 1, 1927.

(e) Placard holders must be so constructed as not to obstruct the wording, change the shape of the placard, or reduce the exposed surface of the placard more than three-eighths of an inch on each side.

NOTE 1: Permanent metal holders designed to provide for secure attachment, easy application, removal, or reversal of placards prescribed in these regulations are required on all new tank cars, on new underframes to which tanks are applied, and on all tank cars receiving general repairs.

(f) Placards as required by §§ 74.540, 74.541, and 74.542 must be securely applied to both sides and both ends of a container car on which a container or containers loaded with explosives, class A or B, or with dangerous articles requiring labels, are placed; or placards must be securely applied to both ends of such a car and to both sides of a container loaded with such articles. Car certificates required by § 74.525 must be securely applied to both sides of a container car on which a container or containers loaded with class A explosives are placed.

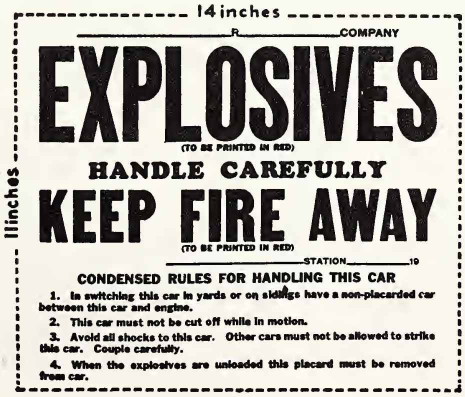
(g) Metal reversible placards, bearing on one side the "Dangerous" placard wording as prescribed in § 74.552 of this part and on the reverse side the "Dangerous—Empty" placard wording as prescribed in § 74.563 of this part may be used in lieu of placard holders prescribed in Note 1 to § 74.549 (e) of this part. The wording on these placards must be kept distinct as to colors and clearly legible.

(h) Placards as required by §§ 74.540, 74.541, and 74.542 must be securely applied to both sides and both ends of car, or to both sides and both ends of truck body or trailer loaded on flat cars, containing explosives or other dangerous articles. Car certificates as required by § 74.525 must be securely applied to both sides of such cars.

§ 74.550 Explosives, class A placard. (a) The "Explosives" placard must be of rectangular shape, measuring 11 by 14 inches, and must bear the wording as shown in the following cut; the printing must be in red and black as follows:

EXPLOSIVES PLACARD

(Reduced Size)


14 inches
11 inches

____________R__________COMPANY

EXPLOSIVES

(TO BE PRINTED IN RED)

HANDLE CAREFULLY

KEEP FIRE AWAY

(TO BE PRINTED IN RED)

____________STATION__________19

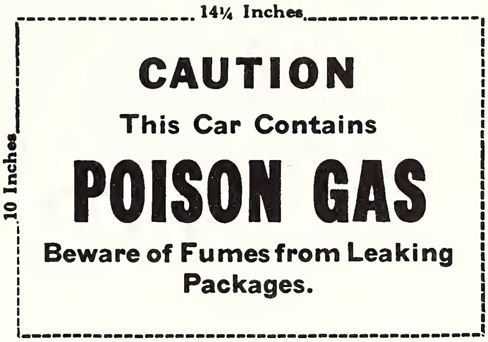
CONDENSED RULES FOR HANDLING THIS CAR

1. In switching this car in yards or on sidings have a non-placarded car between this car and engine.
2. This car must not be cut off while in motion.
3. Avoid all shocks to this car. Other cars must not be allowed to strike this car. Couple carefully.
4. When the explosives are unloaded this placard must be removed from car.

§ 74.551 Poison gas placard. (a) The "Poison gas" placard must be of rectangular shape, measuring 10 by 14¼ inches, and must bear the wording as shown in the following cut; the printing must be in red as follows:

POISON GAS PLACARD

(Reduced Size)


14¼ Inches
10 Inches

CAUTION

This Car Contains

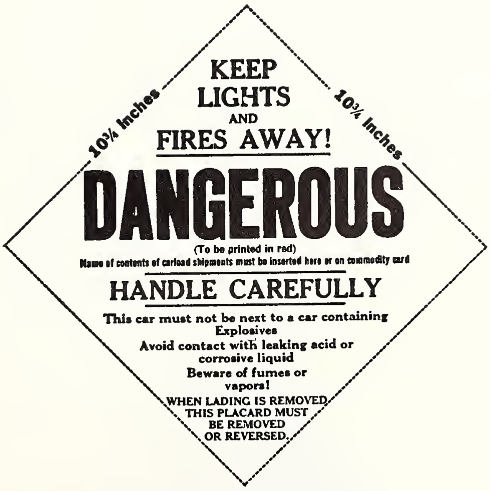
POISON GAS

Beware of Fumes from Leaking Packages.

§ 74.552 Dangerous placard. (a) The "Dangerous" placard must be of diamond shape, measuring 10¾ inches on each side, and must bear the wording as shown in the following cut; the word "Dangerous" must be in red, and the lettering in black, as follows:

DANGEROUS PLACARD

(Reduced Size)


10¾ Inches
10¾ Inches

KEEP LIGHTS AND FIRES AWAY!

DANGEROUS

(To be printed in red)

Name of contents of carload shipments must be inserted here or on commodity card

HANDLE CAREFULLY

This car must not be next to a car containing Explosives

Avoid contact with leaking acid or corrosive liquid

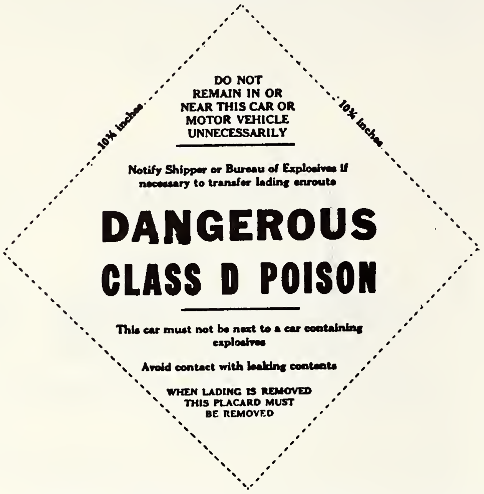
Beware of fumes or vapors!

WHEN LADING IS REMOVED THIS PLACARD MUST BE REMOVED OR REVERSED.

(b) The reverse side of such placards may bear the wording as prescribed for the "Dangerous-Empty" placard. (See § 74.563 of this part.)

§ 74.553 Dangerous—Class D poison placard. (a) The "Dangerous—Class D Poison" placard for class D poisons, must be of diamond shape measuring 10¾ inches on each side, and must bear the wording in red letters as shown in the following cut:

DANGEROUS PLACARD FOR CLASS D POISONS
(Reduced size)

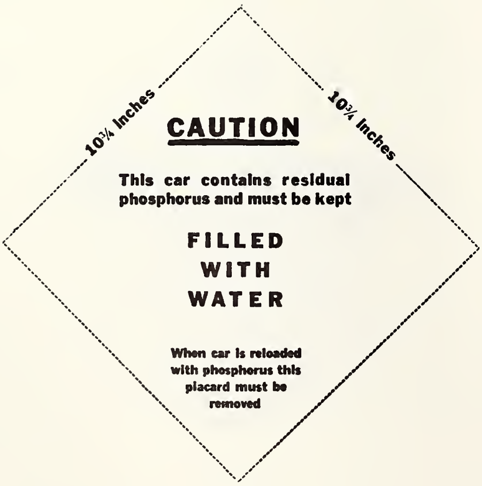

10¾ inches
10¾ inches
DO NOT REMAIN IN OR NEAR THIS CAR OR MOTOR VEHICLE UNNECESSARILY
Notify Shipper or Bureau of Explosives if necessary to transfer lading enroute
DANGEROUS
CLASS D POISON
This car must not be next to a car containing explosives
Avoid contact with leaking contents
WHEN LADING IS REMOVED THIS PLACARD MUST BE REMOVED

§ **74.554 Unauthorized** use of **placards.** (a) Placards prescribed by this part must not be applied to cars containing articles not subject to Parts 71-78 or specifically exempted therefrom.

§ **74.555** "Caution-Residual **phosphorus" placard.** (a) Tank cars previously loaded with phosphorus, when shipped filled with water, must bear a placard reading "Caution—This car contains residual phosphorus and must be kept filled with water." The placard must be of diamond shape measuring 10¾ inches on each side, and must bear the wording in black letters as shown in the following cut:

CAUTION PLACARD FOR RESIDUAL PHOSPHORUS

(Reduced, size)


10¾ Inches
10¾ Inches
CAUTION
This car contains residual phosphorus and must be kept
FILLED WITH WATER
When car is reloaded with phosphorus this placard must be removed

SUBPART D—UNLOADING FROM CARS

§ **74.560 Tank** car delivery. (a) Tank cars containing flammable liquids having a flash point of 80° F. or below, except liquid road asphalt or tar, must not be delivered unless originally consigned or subsequently reconsigned to parties having private-siding (see Note 1 of this section) or to parties using railroad-siding facilities which have been equipped for piping the liquid from tank cars to permanent storage tanks of sufficient capacity to receive contents of car.

(b) No tank car containing compressed gas may be unloaded unless the car is consigned for delivery and unloading on a private track (see Note 1 to subparagraph (2) of this paragraph), except that where no private track is available, delivery and unloading on carrier tracks is permitted provided the following conditions are complied with·

(1) Any tank car of ICC-106A or 110A type (see §§ 78.275, 78.276 or 78.293) may be delivered and the loaded unit tanks may be removed from car frame on carrier tracks, if, before car is accepted for transportation, the shipper has obtained from the delivering carrier and filed with originating carrier, written permission (see Note 2 to subparagraph (2) of this paragraph) for such removal. The consignee must furnish adequately safe mechanical hoist, obtained from the carrier if desirable, by which the tanks are lifted from the car and deposited directly upon vehicles furnished by the consignee for immediate removal from carrier property or tanks must be lifted by adequately safe mechanical hoist from car directly to vessels for further transportation.

(2) Any tank car of other than ICC-106A or 110A type (see §§ 78.275, 78.276, or 78.293, containing anhydrous ammonia, liquefied hydrocarbon or liquefied petroleum gas, and having interior pipes of liquid and gas discharge valves equipped with check valves, may be delivered and unloaded on carrier tracks, if the lading is piped directly from the car to permanent storage tanks of sufficient capacity to receive the entire contents of the car. Such cars may also be stored on a private track or on a carrier track when designated by the carrier for such storage.

NOTE 1: For this purpose, a private track is a track outside of carrier's right-of-way, yard and terminals, and of which the carrier does not own either the rails, ties, roadbed or right-of-way; or a track or portion of a track which is devoted to the purpose of its user, either by lease or written agreement, in which case the lease or written agreement will be considered as equivalent to ownership.

NOTE 2: Carriers should give permission for the unloading of these containers on carrier tracks only where no private siding is available within reasonable trucking distance of final destination. The danger involved is the release of chlorine gas due to accidental injury to container in handling. The exposure to this danger decreases directly with the isolation of the unloading point.

§ **74.561 Tank car unloading.** (a) In unloading tank cars the following rules must be observed (see also § 74.560 of this part for compressed gases):

(1) Unloading operations should be performed only by reliable persons properly instructed and made responsible for careful compliance with this part.

(2) Brakes must be set and wheels blocked on all cars being unloaded.

(3) Caution signs must be so placed on the track or car as to give necessary warning to persons approaching car from open end or ends of siding and must be left up until after car is unloaded and disconnected from discharge connection. Signs must be of metal or other suitable material, at least 12 by 15 inches in size and bear the words "STOP—Tank Car Connected," or "STOP —Men at Work," the word "STOP" being in letters at least 4 inches high and the other words in letters at least 2 inches high. The letters must be white on a blue background.

(4) Before manhole cover or outlet valve cap is removed, tank car must be relieved of all interior pressure by cooling tank with water or venting tank by raising safety valve or opening vent on dome at short intervals. If venting to relieve pressure will cause a dangerous amount of vapor to collect outside the car, venting and unloading must be deferred until pressure is reduced by allowing the car to stand overnight or otherwise cooling the contents. These precautions are not necessary when car is equipped with a manhole cover which hinges inward or with an inner manhole cover which does not have to be removed to unload the car, and when pressure is relieved by piping vapor into a condenser or storage tank.

(b) After pressure is released, seal should be broken and manhole cover removed as follows:

(1) Screw type. Cover must be loosened by placing bar between manhole cover lug and knob. After two complete turns, so that vent openings are exposed, the operation must be stopped, and if there is any sound of escaping vapor, the cover must be again screwed down tightly and interior pressure relieved as prescribed in paragraph (a) (4) of this section, before again attempting to remove the cover.

(2) Hinged and bolted type. All nuts must be unscrewed one complete turn, after which same precautions as prescribed for screw type cover must be observed.

(3) Interior type. All dirt and cinders must be carefully removed from around cover before yoke is unscrewed.

(c) When car is unloaded through bottom outlet valve, manhole cover must be adjusted as follows:

(1) Screw type. Manhole cover must be put in place, but not entirely screwed down, in order that air may enter tank through vent holes in threaded flange of cover.

(2) Hinged and bolted type. A small wooden block should be placed under one edge of cover.

(3) Interior type. Screw must be tightened up in yoke so that cover will be brought up within one-half inch of closed position.

(d) When unloading through bottom outlet of cars equipped with interior manhole type of covers, and in all cases where unloading is done through the manhole (unless special covers are used, provided with safety-vent opening and tight connection for discharge outlet), the manhole must be protected against entrance of sparks or other sources of ignition of vapor by asbestos or metal covers or by being covered and surrounded with wet burlap. Burlap must be kept damp by replacement or the application of water as needed.

(e) Seals or other substances must not be thrown into the tank. Also care must be taken to avoid spilling any of the contents over car or tank.

(f) Valve rod handle or control in dome must be operated a few times to see that outlet valve in bottom of tank is on its seat before valve cap is removed.

(g) Valve cap, or reducer when large outlet is to be used, must be removed with suitable wrench after set screws are loosened and a pail is placed in position to catch any liquid that may be in outlet chamber. If valve cap or reducer does not unscrew easily, it must be tapped lightly with mallet or wooden block in an upward direction. If leakage shows upon starting the removal, cap or reducer must not be entirely unscrewed, but sufficient threads must be left engaged and sufficient time allowed to permit escape of any accumulation of liquid in the outlet chamber. If leakage stops or initial rate of leakage dinimshes materially, cap or reducer may be entirely removed. If initial rate of leakage continues, further efforts must be made to seat the outlet valve, see paragraph (f) of this section. If this fails, the cap or reducer must be screwed up tight and tank must be unloaded through the dome. If upon removal of the outlet cap the outlet chamber is found to be blocked with frozen liquid or any other matter, replace cap immediately and make careful examination to determine that outlet casting has not been cracked. If the obstruction is not frozen liquid, the car must be unloaded through the dome. If the obstruction is frozen liquid and no crack has been found in the outlet casting, the car may, if circumstances require it, be unloaded from the bottom as follows:

(1) Remove cap and attach unloading connections immediately. Then, before opening the valve inside the tank car, apply steam to outside of outlet casting or wrap casting with burlap or other rags and apply hot water to melt the frozen liquid. In any event, top unloading is considered safer than bottom unloading.

(h) Unloading connections must be securely attached to unloading pipes on dome or to bottom discharge outlets before discharge valves are opened.

(i) Tank cars must not be allowed to stand with unloading connections attached after unloading is completed, and throughout the entire period of unloading, or while car is connected to unloading device, the car must be attended by the unloader.

(j) If necessary to discontinue unloading a tank car for any reason, all unloading connections must be disconnected. All valves must first be tightly closed, and the closures of all other openings securely applied.

(k) As soon as a tank car is completely unloaded, all valves must be made tight, the unloading connections must be removed and all other closures made tight, except that heater coil inlet and outlet pipes must be left open for drainage. The manhole cover must be applied by the use of a bar or wrench, the outlet valves reducer and outlet valve cap by the use of a wrench having a handle at least 36 inches long, and the outlet valve cap plug, end plug, and all other closures of openings and of their protective housings by the use of a suitable tool.

(l) Railroad defect cards must not be removed.

(m) Ground around connections must be covered with fresh, dry sand or dirt, if oil or gasoline has been spilled previously.

(n) All tools and implements used in connection with unloading should be kept free from oil, dirt, and grit.

§ 74.562 Removal of placards and car certificate after unloading. (a) When lading requiring placards or car certificates is removed from cars other than tank cars, placards and car certificates must be removed by the party unloading the car.

(b) After tank car is unloaded, the party unloading the car must remove all shipping cards and "Dangerous" placards from car, or may replace or cover the placards with the "Dangerous—Empty" placards prescribed in § 74.563 of this part, or reverse the reversible metal placards so as to exhibit the "Dangerous—Empty" wording, and must promptly notify the railroad agent that car is empty.

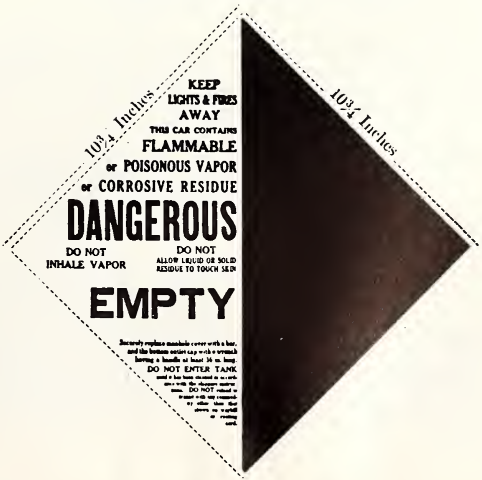
(c) Tank cars filled with water after unloading phosphorus must have the "Dangerous" placards replaced by the caution placard for residual phosphorus as prescribed in § 74.555.

§ 74.563 "Dangerous—Empty" placard. (a) "Dangerous—Empty" placards must measure 10¾ inches on each side. The printing must be as shown in the cut in this section, in black on strong white paper, or on tag board designated commercially as No. 2 tag board, and weighing 150 pounds per ream of sheets 24 inches by 36 inches, and having a resistance of not less than 60 pounds per square inch, Mullen test.

(b) The reverse side of such placards may bear the wording as prescribed for the "Dangerous" placard. (See § 74.552 of this part.)

(c) Paper placards must be securely pasted over the "Dangerous" placards pasted on metal placard boards provided for the purpose. Tag board placards must be securely tacked to wooden boards or inserted in holders provided for the purpose.

"DANGEROUS—EMPTY" PLACARD



NOTE 1: The words "Keep lights and fires away" and "Flammable or poisonous vapor" may be omitted from placards attached to tank cars which previously contained alkaline corrosive liquids or corrosive liquids which do not react with the metal wall or lining of the tank to form a flammable or poisonous gas.

§ 74.564 **Removal and disposition of explosives and other dangerous articles at destination**—(a) Delivery at non-agency stations. Shipments of explosives must not be unloaded at non-agency stations unless the consignee is there to receive them or unless properly locked and secure storage facilities are provided at that point for their protection.

(1) If delivery cannot be so made, shipment must be taken to next or nearest agency station for delivery.

(b) Delivery at agency stations. Carrier must require consignee to remove shipments of explosives and other dangerous articles from carrier's property within 48 hours after notice of arrival has been sent or given. Saturdays, Sundays, and holidays are not included. If not so removed, carrier must immediately dispose of the shipments as follows:

(1) Class A explosives, by storage at the expense of the owner or by return to the shipper if reasonably safe storage is not available; by sale; when necessary to safety, by destruction under supervision of a competent person.

(2) Explosives and other dangerous articles, except class A explosives, in carload and less-than-carload lots as prescribed in subparagraphs (3) and (4) of this paragraph.

(3) Carload shipments: By storage on carrier's property; by storage on other than carrier's property, if safe storage on carrier's property is not available; by sale at expiration of 15 calendar days after notice of arrival has been sent or given to consignee, provided consignor has been notified of nondelivery at expiration of 48-hour period and orders for disposition have not been received.

(4) Less-than-carload shipments: By return to shipper if notice of nondelivery was requested and given consignor as prescribed by carrier's tariff, and orders for return to shipper have been received; by storage on carrier's property; by storage on other than carrier's property, if safe storage on carrier's property is not available; by sale at expiation of 15 calendar days after notice of arrival has been sent or given to consignee, provided consignor has been notified of nondelivery at expiration of 48-hour period and orders for disposition have not been received.

§ 74.565 **Violations and accidents to be reported.** (a) Consignees must report promptly to the Bureau of Explosives all instances of improper staying and broken, leaking, or defective containers of explosives or other dangerous articles in shipments received by them.

(b) The Bureau of Explosives, upon receipt of reports from consignees, should promptly report to the shipper full particulars covering all cases of defective packing, improper staying, leaking and/or broken shipping containers and rough treatment of cars resulting in leakage or damage to shipping containers or staying.

§ 74.566 **Cleaning cars.** (a) Cars which have contained arsenic, arsenate of lead, sodium arsenate, calcium arsenate, Paris green, calcium cyanide, potassimu cyanide, sodium cyanide, or other poisonous articles, which show any evidence of leakage from packages, must be thoroughly cleaned after unloading before cars are again placed in service.

(b) After unloading poisons from steel hopper cars, cars must be thoroughly flushed out with water, except that cars used exclusively in this service under the provisions of § 73.368 (a) shall not be subject to this requirement.

(c) All loose powder or other explosive or any other dangerous article which has leaked from packages must be carefully removed from car and other railroad property.

(d) Any box car which, after use for the transportation of radioactive materials in carload lots, is contaminated with such materials to the extent that a survey of the interior surface shows that the beta-gamma radiation is greater than 10 milliroentgens physical equivalent in 24 hours or that the average alpha contamination is greater than 500 disintegrations per minute per 100 square centimeters shall be thoroughly cleaned in such a manner that a resurvey of the interior surface shows the contamination to be below these levels. A certificate to that effect must be furnished to the local agent of the carrier. Cars which are used solely for he transportation of radioactive materials are exempt from the provisions of this section.

§ 74.567 **Flammable vapors.** (a) A box car or container car placarded "Dangerous," or known to contain flammable liquids, gases, or vapors must not be entered with a lighted open-flame lantern, torch, or other fire, until both car doors have been opened and sufficient time allowed for ventilation and escape of any vapors. The presence of these vapors will generally be indicated by characteristic odors. When leakage is continuous, ventilation will not remove the danger. The leaking package should be located and removed using electric lights or waiting for daylight.

SUBPART E—HANDLING BY CARRIERS BY RAIL FREIGHT

§ 74.575 **Restrictions.** (a) When local conditions make the acceptance, transportation, or delivery of explosives or other dangerous articles unusually hazardous, local restrictions may be imposed by the carrier.

(b) All carriers must report to the Bureau of Explosives for publication full information as to restrictions which may be imposed against the acceptance, delivery, or transportation of explosives or other dangerous articles, over any portion of their lines.

§ 74.576 **Intermediate shippers and carriers.** (a) Forwarding companies must have on file shipper's certified bill of lading or shipping order, and know that packages delivered to carrier for transportation comply with Parts 71-78.

(b) Every carrier offering or delivering for rail transportation any loaded motor vehicle or any loaded motor vehicle trailer, semi-trailer, or container containing any shipment of an explosive or other dangerous article shall show on the shipping order, shipping paper, transfer sheet, or other billing issued in lieu thereof, in addition to the description of the vehicle or container, the proper and definite name of the commodity as shown in § 72.5 and the color or kind of label or kind of placards applied.

§ 74.577 **Shipping days for explosives.** (a) When practicable at any point, regular days should be assigned for receiving from shippers less-than-carload lots of explosives, class A, as shown in Part 73.

(b) To enable the carrier to provide proper cars at stations where less-than-carload shipments of explosives, class A, are accepted for loading by the carrier, the shipper must give to the carrier not less than 24 hours' notice of his intention to offer such shipments, and state their destinations. When a regular day to receive all explosives shipments offered at such a station has been appointed, this notice may be waived by the carrier, but the explosives shipments must be delivered on such days in time to permit proper inspection, billing, and loading on that days.

§ 74.578 **Flammable vapors.** (a) A box car or container car placarded "Dangerous," or known to contain flammable liquids, must not be entered with a lighted open-flame lantern, torch, or other fire, until both car doors have been opened and sufficient time allowed for ventilation and escape of any vapors. The presence of these vapors will generally be indicated by characteristic odors. When leakage is continuous, ventilation will not remove the danger. The leaking package should be located and removed, using electric lights or waiting for daylight.

§ 74.579 Cars containing lading which has been fumigated or treated with flammable liquids, flammable gases, poisonous liquids or solids, or poisonous gases. (a) Delivery to carrier or transportation of cars containing lading fumigated or treated with flammable liquid or flammable gas is prohibited until 48 hours have elapsed after such fumigation or treatment, or until car has been ventilated so as to remove danger of fire or explosion due to the presence of flammable vapors.

(b) Cars containing lading which has been fumigated or treated with poisonous liquid, solid, or gas, such as carbolic acid, liquid or solid, chlorpicrin, hydrocyanic acid, methyl bromide, etc., must be placarded on each door or near thereto with placard reading as follows (for cleaning cars, see § 74.566):

(Reduced size)

(Red lettering on white cardboard)

10 INCHES

8 INCHES

DANGER

The lading of this car has been

FUMIGATED or TREATED

with

(Name of poisonous liquid, solid, or gas)

BEFORE UNLOADING, open both doors and DO NOT ENTER until car is free of gas. REMOVE ALL POISONOUS MATERIAL before release of empty car.

§ 74.580 Violations must be corrected. (a) All violations discovered must be corrected before forwarding shipments of explosives.

§ 74.581 Routing shipments. (a) Before any shipment of explosives, class A, as named in §§ 73.53 to 73.87, destined to a point beyond the lines of the initial carrier, is accepted from a shipper, the initial carrier must ascertain that the shipment can go forward by the route designated, and to avoid delays en route the initial carrier must be in possession of full rate information, before forwarding the shipment.

§ 74.582 Movement to be expedited. (a) Carriers must forward shipments of explosives and other dangerous articles promptly and within 48 hours, Saturdays, Sundays, and holidays excluded after acceptance at originating point or receipt at any yard, transfer station, or interchange point, except that where bi-weekly or weekly service only is performed, shipments of explosives and other dangerous articles must be forwarded on the first available train.

(b) No tank car loaded with flammable liquid or compressed flammable gas shall be received and held at any point, subject to forwarding orders, so as to defeat the purpose of this section or of § 74.560 of this part.

§ 74.583 Examination of shipping order and packages. (a) Carriers must examine shipping order and determine that proper certificate is given and that packages are not broken or leaking when offered for transportation.

§ 74.584 Waybills, switching orders, or other billing. (a) The revenue waybill, astray waybill, switching order or any other billing issued in lieu thereof, prepared from the shipping order or other shipping paper, or shipping orders used as waybills, must describe the article by shipping name as prescribed in § 72.5 and must show the color or kind of label notations for less-than-carload shipments or placard notations for carload shipments of explosives and other dangerous articles and placard indorsement as follows:

	Label notation to follow entry of the article on the billing	Placard notation to follow entry of the article on the billing	Placard endorsement must be ⅜" high and appear on the billing near the space provided for the car number
For high explosives, initiating explosives, low explosives, and blasting caps or electric blasting caps more than 1,000 in quantity, class A	None	"Explosives Placard"	"Explosives"
For explosive chemical ammunition containing class A poison gas	Poison Gas label	"Explosives and Poison Gas Placard"	"Explosives" and "Poison Gas"
For explosives, class B	None	"Dangerous Placard"	"Dangerous"
For explosives, class C	None	None	None
For flammable liquids	Red label	"Dangerous Placard"	"Dangerous"
For flammable solids	Yellow label	"Dangerous Placard"	"Dangerous"
For oxidizing materials	Yellow label	"Dangerous Placard"	"Dangerous"
For corrosive liquids	White label	"Dangerous Placard'	"Dangerous"
For compressed nonflammable gases in containers other than tank cars	Green label	None	None
For compressed nonflammable gases in tank cars	None	"Dangerous Placard"	"Dangerous"
For compressed flammable gases	Red Gas label	"Dangerous Placard"	"Dangerous"
For poisonous gases or liquids, class A	Poison Gas label	"Poison Gas Placard"	"Poison Gas"
For poisonous liquids or solids, class B	Poison label	"Dangerous Placard"	"Dangerous"
For tank cars, filled with water and last containing phosphorus	None	"Caution-this car contains residual phosphorus and must be kept filled with water"	"Caution-Residual Phosphorus"
For tear gases, class C	Tear Gas label	None	None
For radioactive materials, class D, poison	Radioactive materials label	"Dangerous class D Poison Placard"	"Dangerous class D Poison"

(b) Billing prepared from the shipping order or other shipping paper covering shipments of blasting caps, must, in addition, show the number of blasting caps in the shipment.

(c) Waybills, manifests, or memorandums for shipments offered for transportation by carrier by water must show the label notations as prescribed in this section.

(d) Abbreviations must not be used on shipping orders or billing for explosives or other dangerous articles.

(e) When the initial movement is a switching operation, the switching order, switching receipt or switching ticket, and copies thereof, prepared by the shipper, or by the carrier under the shipper's written authority, must bear the placard indorsement and the shipper's certificate prescribed by § 73.430 and paragraph (a) of this section; for other switching movement, the switching ticket prepared by a railway employee must show the kind of placard required.

(f) The car ticket, card waybill, running slip, envelope containing waybills, or any other billing for any loaded car which in this chapter should bear "Explosive," "Dangerous," "Dangerous—Class D poison," or "Poison Gas" placards must have plainly stamped, or plainly written on the face of such billing, near the car number, in letters not less than three-eighths of an inch high, the words "Explosive," "Dangerous," "Dangerous—Class D Poison," or "Poison Gas;" and for container cars must also show which of the containers loaded thereon contain dangerous articles.

(g) For tank cars not loaded, the billing must show the word "Empty," except that for tank cars previously loaded with white or yellow phosphorus the billing must show the words "Caution—This car contains residual phosphorus and must be kept filled with water."

(h) At stations, or other points, where other shipments of any material are loaded into a properly certified and placarded car received with shipments of explosives, or when shipments of explosives are transferred or reloaded, or carload shipments are reconsigned, a record must be kept of the car, originating point, carrier's name and date of car certificate. The blocking or bracing at these points to secure the lading must be inspected as provided in § 74.525 and certified for compliance with these regulations by the person making the inspection who shall sign the car certificates immediately below the signature which appears on certificate No. 2 of the original car certificates attached to the car.

§ **74.585 Nonagency shipments.** (a) If shipments of explosives are accepted at nonagency stations, provisions must be made for the proper certification and placarding of cars, examination of shipments, and loading and staying of packages in cars.

§ **74.586 Handling explosives and other dangerous articles.** (a) In handling packages of explosives at stations and in transferring them to and from cars the greatest care must be taken, and shocks or falls liable to injure the containers must be avoided. Where an inclined chute is employed, such chute shall be constructed of 1-inch planed boards with side guards 4 inches high extending 3 inches above top face of bottom of chute and, throughout its length, fastened with brass screws. D-shaped wooden strips or runners, not more than 6 inches apart and running lengthwise of chute must be fastened to the upper surface of the bottom board by means of glue and wooden pegs extending through the bottom board and runners. Chutes must be occasionally wiped down with waste moistened with machine oil when dynamite packages are being handled.

(b) A stuffed mattress, 4 feet wide by 6 feet long and not less than 4 inches thick, or a heavy jute or hemp mat of like dimensions, must be placed under the discharging end of the chute.

(c) Careful men must be chosen to handle explosives, the platform and the shoes of the men must be as free as possible from grit, and all possible precautions must be taken against fire.

(d) Unauthorized persons must not have access to explosives and other dangerous articles at any time while articles are in the custody of the carrier.

(e) Explosives and other dangerous articles must be kept in a safe place while being held for delivery or loading.

(f) In handling packages containing dangerous articles other than explosives at stations, and to and from cars, care must be taken to prevent their falling or being broken. Heavy packages should be trucked, rolled, or moved by use of skids or other satisfactory devices and must not be dropped from trucks, platforms, or cars. Planks for rolling trucks from platforms to cars should have beveled ends.

(g) Acid or other corrosive-liquid carboys should be handled so as not to spill the contents. "Empty" carboys, so called, should be handled with necks up, and with sufficient care to prevent burns to clothing or person from leaking acid or other corrosive liquid.

§ **74.587 Lights.** (a) When necessary to use lights while handling explosives, it is recommended that where practicable incandescent electric lights be provided.

§ **74.588 Disposition of damaged or astray shipments.** (a) Packages of explosives found injured or broken in transit may be recoopered when this is evidently practicable and not dangerous. A broken box of high explosives that can not be recoopered should be reinforced by stout wrapping paper and twine, placed in another strong box and surrounded by dry, fine sawdust or dry and clean cotton waste or elastic wads made from dry newspapers. A ruptured can or keg should be sealed with tape and should be inclosed in a grain bag of good quality and boxed. Injured packages thus protected and properly marked may be forwarded. The box and waybill should be marked to indicate that it has been repacked.

(b) Particles of explosive compositions from damaged containers possibly may be strewn on car floors or freight, and due care should be exercised in repacking such containers that no sparks may be produced by contact of metal or other hard surfaces, or otherwise. Water will prevent the explosion of practically all explosive substances except dynamite, and in such cases car floors should be thoroughly swept, and washed with a plentiful supply of water. Use of ironwheel trucks, metal hammers or other metal tools that may produce sparks, should be avoided. This restriction does not apply to metal tools made of brass, bronze or copper.

(c) Unless they are leaking, or in a manifestly insecure condition, packages of dangerous articles other than explosives in transit must be forwarded to destination and report made of any violation observed. Leaking packages must not be forwarded until repaired or reconditioned.

(d) Packages of explosives showing evidence of leakage of liquid ingredients must (1) be returned immediately to shipper, if at point of shipment; or (2) disposed of to a person who is competent and willing to remove them from railway property, if leakage is discovered while in transit; or (3) removed immediately by consignee, if shipment is at destination.

(e) When disposition cannot be made as above, the leaking boxes must be packed in other boxes large enough to permit inclosure, and the leaking boxes must be surrounded by at least 2 inches of dry, fine sawdust or dry and clean cotton waste, and be stored in station magazine or other safe place until arrival of an inspector of the Bureau of Explosives, or other authorized person, to superintend the destruction or disposition of the condemned material.

(f) An astray shipment of explosives must be forwarded immediately to its destination if known, or returned to the shipper by the most practicable route, provided a careful inspection shows the packages to be in proper condition for safe transportation.

(g) When a package in an astray shipment is not in proper condition for safe transportation (see paragraphs (a), (d), and (e) of this section), or when name and address of consignee or shipper are unknown, disposition must be made as prescribed by paragraphs (d) and (e) of this section.

(h) An astray package of dangerous articles other than explosives of known destination and in proper condition for safe transportation, must be forwarded immediately on an "astray bill," showing proper label notation and placard indorsement, as prescribed by § 74.584 (a) to (f) of this part. When necessary to replace a label and doubt exists as to the kind, the red label should be used.

§ **74.589 Handling, cars (a) Definitions.** (1) "Person" means any individual, partnership, corporation, association, joint stock company, business trust or other organized group of persons, or any trustee, receiver, assignee, or personal representative, and includes any department or agency of the United States, any State, the District of Columbia, or any other political, governmental or legal entity;

(2) "Railroad" means any person engaged in transportation as a common carrier by rail and includes its agents or employees;

(3) "Engine" means any locomotive, propelled by any form of energy, used by a railroad;

(4) "Freight car" means any vehicle used for the transportation of property by rail;

(5) "Passenger car" means any vehicle used for the transportation of passengers by rail;

(6) "Combination car" means any vehicle used for the transportation of both property and passengers by rail;

(7) "Occupied caboose" means any vehicle used by railroad employees, caretakers, or others authorized to ride therein;

(8) "A train" is one or more engines coupled together with or without cars displaying markers;

(9) "Freight train" means one or more engines coupled with one or more freight cars, displaying markers;

(10) "Passenger train" means one or more engines coupled with one or more passenger cars carrying passengers, displaying markers;

(11) "Mixed train" means one or more engines coupled with one or more freight cars and passenger cars carrying passengers, displaying markers;

(12) "Placarded car" shall be construed to embrace also any car which under this part is required to be placarded.

(13) "Pickup and/or setoff service" shall be construed to mean trains in service that pick up and/or set off one or more cars at three or more stations enroute; trains having cars from which less-than-carload freight is loaded or unloaded enroute; or trains regularly scheduled to perform pickup and/or set-off service which on some days make less than three stops.

(b) Placards on cars. A car requiring car certificates and "Explosives," "Dangerous," "Dangerous—Class D Poison," "Poison Gas," or "Caution-Residual Phosphorus" placards under the provisions of this part shall not be transported unless such freight car is at all times placarded and certified as required by this part. Placards and car certificates lost in transit shall be replaced at next inspection point and those not required shall be removed.

(1) At points where trains are inspected, cars placarded "Explosives" and adjacent cars shall be inspected; such cars shall continue in movement only when inspection shows them to be in condition for safe transportation.

(c) Switching cars containing explosives or poison gas or placarded trailers on flat cars. A car placarded "Explosives" or placarded "Poison Gas" or any flat cars carrying a placarded trailer shall not be cut off while in motion. No car moving under its own momentum shall be allowed to strike any car placarded "Explosives" or placarded "Poison Gas" or any flat car carrying a placarded trailer nor shall any such car be coupled into with more force than is necessary to complete the coupling.

(1) When transporting a car placarded "Explosives" in terminals, yards, side tracks, or sidings, such cars shall be separated from the engine by at least one nonplacarded car.

(2) Closed cars placarded "Explosives" shall have doors closed before they are moved.

(d) Switching of cars containing dangerous articles. In switching operations where use of hand brakes is necessary, a placarded loaded tank car, or a draft which includes a placarded loaded tank car shall not be cut off until the preceding car or cars clear the ladder track and the draft containing the placarded loaded tank car, or a placarded loaded tank car shall in turn clear the ladder before another car is allowed to follow.

(1) In switching operations where hand brakes are used, it shall be determined by trial that a car placarded "Dangerous" or that a car occupied by a rider in a draft containing a car placarded "Dangerous" has its hand brakes in proper working condition before it is cut off.

(e) Placement of freight cars containing explosives in yards, on sidings, or sidetracks. Cars placarded "Explosives" shall be so placed that they will be safe from all probable danger of fire. Freight cars placarded "Explosives" shall not be placed under bridges or overhead highway crossings, nor in or alongside of passenger sheds or stations except for loading or unloading purposes.

(f) Notice to crews of cars containing explosives in freight trains or mixed trains. At all terminals or other places where trains are made up by crews other than road crew accompanying the outbound movement of cars, the railroad shall execute a consecutively numbered notice showing the location in the freight train or mixed train of every car placarded "Explosives." A copy of such notice shall be delivered to the train and engine crew and a copy thereof showing delivery to the train and engine crew shall be kept on file by the railroad at each point where such notice is given. At points where train or engine crews are changed, the notice shall be transferred from crew to crew.

(g) Position in freight train or mixed train of cars containing explosives. In a freight train or a mixed train either standing or during transportation thereof, a car placarded "Explosives" shall, when length of train permits, be placed not nearer than the sixteenth car from both the engine or occupied caboose, except:

(1) When the length of freight train or mixed train will not permit it to be so placed, it shall be placed near the middle of the train.

(2) When transported in a freight train made up in "blocks" or classifications, a car placarded "Explosives" shall be placed near the middle of the "block" or classification in which moving, but not nearer than the sixth car from both the engine or occupied caboose.

(3) When transported in a freight train or a mixed train performing pickup and/or setoff service, it shall be placed not nearer than the second car from both the engine or occupied caboose, except as provided in paragraph (1) of this section.

(h) Separating cars placarded "Explosives" from other cars in trains. In a freight train or a mixed train either standing or during transportation thereof, a car placarded "Explosives" must not be handled next to:

(1) Occupied passenger car; except as provided in paragraph (L) of this section.

(2) Occupied combination car; except as provided in paragraph (L) of this section.

(3) Any car placarded "Dangerous" or "Dangerous—Class D Poison."

(4) Engine.

(5) Any car placarded "Poison Gas."

(6) Wooden underframe car (except on narrow gauge railroads).

(7) Loaded flat car, except that cars carrying trailers or containers placarded "EXPLOSIVES" as authorized by the regulations in this chapter may be coupled to each other. (Note: Flat cars equipped with permanently attached ends of rigid construction shall be considered as open-top cars. See subparagraph (8) of this paragraph.)

(8) Open-top car when any of the lading protrudes beyond the car ends or when any of the lading extending above the car ends is liable to shift so as to protrude beyond the car ends.

(9) Car equipped with automatic refrigeration or any other apparatus utilizing an open-flame light or an internal combustion engine in its operation.

(10) Car containing lighted heaters, stoves, or lanterns.

(11) Car loaded with live animals or fowl, occupied by an attendant.

(12) Occupied caboose, except as provided in paragraph (1) of this section.

(i) Position in train of loaded placarded tank car. In a freight train or a mixed train, except a train consisting entirely of placarded loaded tank cars and as provided in paragraph (j) of this section, a placarded loaded tank car shall when the length of the train permits, be not nearer than the sixth car from the engine, occupied caboose or passenger car.

(1) When the length of the freight train or mixed train will not permit it to be so placed, it shall be not nearer than the second car from the engine, occupied caboose or passenger car.

(2) When transported in a freight train engaged in "pickup" or "setoff" service, a placarded loaded tank car shall be not nearer than the second car from both engine or occupied caboose.

(j) Separating loaded tank cars placarded "Dangerous" from other cars in trains. In a freight train or mixed train either standing or during transportation thereof, a placarded loaded tank car must not be handled next to:

(1) Occupied passenger car, other than gas handlers accompanying shipment.

(2) Occupied combination car, other than gas handlers accompanying shipment.

(3) Any car placarded "Explosives."

(4) Engine, (except when train consists only of placarded loaded tank cars).

(5) Any car placarded "Poison Gas."

(6) Wooden under-frame car (except on narrow gauge railroads).

(7) Loaded flat car. (Note: Flat cars equipped with permanently attached ends of rigid construction shall be considered as open-top cars. See subparagraph (8) of this paragraph.)

(8) Open-top car when any of the lading protrudes beyond the car ends or when any of the lading extending above the car ends is liable to shift so as to protrude beyond the car ends.

(9) Car equipped with automatic refrigeration or any other apparatus utilizing an open-flame light or an internal combustion engine in its operation.

(10) Car containing lighted heaters, stoves, or lanterns.

(11) Car loaded with live animals or fowl, occupied by an attendant.

(12) Occupied caboose, (except when train consists only of placarded loaded tank cars).

(k) Position in freight train or mixed train of cars placarded "Poison Gas" or containing poison liquids, class A. In a freight train or mixed train either standing or during transportation thereof, a car placarded "Poison Gas" or containing poison liquids, class A, shall not be next to other freight cars placarded "Explosives" of cars placarded "Dangerous."

(l) Position in freight train or mixed train of cars placarded "Explosives" or "Poison Gas," or both, when accompanied by cars carrying guards or gas handling crews. A car requiring "Explosives" or "Poison Gas" placards, or both, shall be next to and ahead of the car occupied by the guards or gas handling crews accompanying such car; except that when the car occupied by guards or gas handling crews is equipped with a lighted heater or stove it shall be the fourth car behind a car or cars requiring "Explosives" placards.

(m) Cars containing explosives or poison gas and tank cars placarded "Dangerous" in passenger or mixed trains. Cars containing explosives, class A, poison gases or liquids, class A, and tank cars requiring "Dangerous" placards shall not be transported in a passenger train. Such cars may be transported in mixed trains but only at such times and between such points that freight train service is not in operation.

(1) Cars containing explosives, class A, poison gases or liquids, class A, and tank cars placarded "Dangerous" shall not be transported next to occupied cabooses or cars carrying passengers in mixed trains, except as provided in paragraph (l) of this section.

(2) When a car containing explosives, class B, or dangerous articles other than explosives requiring labels (not including class A poison gases or liquids is moved in a mixed train and such car is not occupied by an employee of the carrier, placards must be applied to the car as required by this part.

(n) Position in train of cars containing class D poison. In a freight train or mixed train either standing or during transportation thereof, a car placarded "Dangerous —Class D Poison" must not be handled next to cars placarded "Explosives" or next to carload shipments of undeveloped film.

§ 74.590 Record of change of seals of cars of explosives to be made. (a) When a car seal is changed on a car placarded "Explosives" while en route or before delivery to a consignee, a record must be made showing the following information which shall be shown on or attached to waybill or other form of memorandum which shall accompany car to destination.

....	....	....
Railroad	Place	Date
....	....	....
Car initials	Car number	

Number or description or seal broken ....

....

Number or description of seal used to reseal car ....

....

Reasons for opening car ....

....

Conditions of load ....

....

Name and occupation of person opening car ....

....

§ 74.591 Car magazines. (a) When specially authorized by the carrier, class A explosives in quantity not exceeding 150 pounds may be carried in construction or repair cars when the packages of explosives are placed in a "magazine" box made of sound lumber not less than 1 inch thick, covered on the exterior with metal, and provided with strong handles. This box must be plainly stenciled on the top, sides, and ends, in letters not less than 2 inches high, "EXPLOSIVES—DANGEROUS—HANDLE CAREFULLY." The box must be provided with strong hinges and with a lock for keeping it securely closed. Vacant space in the box must be filled with a cushioning material such as sawdust or excelsior, and the box must be properly stayed to prevent movement within the car. The car, when not occupied by a responsible employe, must be placarded "EXPLOSIVES."

§ 74.592 Cotton fires. (a) When fire occurs in a shipment of cotton in transit at a point where it cannot be reconditioned, and where arrangements cannot be made with the originating line to sell it, all burnt cotton in the shipment must be stored under observation in as safe a place as practicable for not less than 10 days, and without further evidence of fire, before forwarding. The billing must be changed to read "Burnt Cotton," and the material must be forwarded as a dangerous article. (See § 73.159).

§74.593 Charcoal fires. (a) When fire occurs in charcoal in transit, water should not be used if it is practicable to locate and remove the material on fire, since wet charcoal is much more liable to ignite spontaneously, and the fire cannot be stopped permanently by the use of water. Any material which has become wet in extinguishing first must be removed from the car and not shipped; the remainder of the charcoal must be held under observation in a dry place for at least five days before forwarding.

§ 74.594 Leaking tank cars. (a) Action in any particular case will depend upon existing conditions, and good judgment will be necessary to avoid disastrous fires on the one hand and useless sacrifice of valuable property on the other.

(b) Volatile, flammable, and combustible liquids, or flammable liquefied gases, such as gasoline, naphtha, petroleum oils, or liquefied petroleum gas, in large quantity and spread over a large surface, will form vapors that will ignite at a considerable distance, depending on the kind and quantity of liquid and the direction and force of the wind. Many of the liquids, regarded as safe to carry under ordinary conditions and transported in tank cars without the "Dangerous" placard, should still be treated as dangerous in handling a wreck.

(c) When tank cars are leaking, all lights or fires near them should be extinguished or removed until it is determined that contents are not flammable or combustible. Incadescent electric lights, or portable electric flash-lights should be used when available.

(d) Lanterns necessarily used for signaling should be kept on the side from which the wind is blowing and at as high an elevation as can be obtained. The vapors will go with the wind but not against it. The ash pan and fire box of a locomotive or steam derrick are sources of danger, especially when wind is blowing across the wrecked or leaking tank car toward them. Wrecks involving tank cars should in no case be approached with lighted pipes, cigars, or cigarettes, and all spectators should be kept away.

(e) Effort should be made to prevent the spread of liquid leakage over a large surface by collecting it in any available vessels or draining it into a hole or depression at a safe distance from the track. When necessary, trenches should be dug for this purpose.

(f) It is not safe to drain inflammable or comustible liquids in large quantities into a sewer, since vapors may thus be carried to distant points and there ignited. Care should be exercised also not to permit these liquids to drain into streams of water which may be used by irrigation plants or for watering stock. Dry earth over spilled liquid will decease the rate of evaporation and the danger. A stream of these liquids on the ground should be dammed and dry earth thrown on the liquid as it collects.

(g) Sudden shocks or jars that might produce sparks or friction should be avoided. When possible, the wrecked cars should be jacked carefully into position after removing other cars and freight that might be injured by fire. Only as a last resort, to meet an emergency, should a wrecked car be moved by dragging, and when this is done all persons should be kept at a safe distance. (See § 74.600 of this part).

(h) No unnecessary attempt should be made to transport a damaged tank car from which flammable or combustible liquid is leaking. Safety in short movements may be secured by attaching a receptacle under small leaks to prevent spread of these liquids over tracks. Tracks at intervals in rear of a moving car should be covered with fresh earth to prevent fire overtaking the car. Engines should be kept away; also spectators who may be smoking. If damaged car is derailed, and not in a position to obstruct or endanger traffic, leaks should be stopped as far as possible, and the car should be left under guard until another tank car or sufficient receptacles can be provided for the transfer of the liquid, which should be transferred by pumping when practicable.

(i) Highly volatile products cannot be transferred in the usual way by a vacuum pump. The pump can only be used when placed so that liquid flows to it from the tank by gravity.

(j) Whenever the leaking condition of a tank car is such that transfer of lading has been necessary, the car must be stenciled on both sides, in letters three inches in size, adjacent to the car number, "LEAKY TANK. DO NOT LOAD UNTIL REPAIRED," and indicate and mark at the location of the leak with the symbol "X," and the owner must be immediately notified by wire, such notification to indicate definitely location of leak. Stenciling must not be removed until the tank is repaired.

(k) Even a tank that is not leaking is liable to be ruptured by the use of slings, and slipping of chain slings may produce sparks. Saving of the contents of the tank is not as important as the prevention of fire.

(l) An empty or partially empty tank car, with or without placards, is very liable to contain explosive gases, and open flame lights must not be brought near it. (See § 74.595 of this part).

§ **74.595 Examination of empty tank cars.** (a) Lighted lanterns. Many fatal accidents have resulted from using lanterns or lighted matches to examine the interior of empty tank cars or in using hot rivets to repair unsteamed tank cars, which may contain flammable vapors even when the previous lading was not of flash point below 80° F. Only incandescent electric lights should be used for this examination. Fumes in any empty tank car should be considered as injurious to a person entering it. In no case should an empty tank be entered before it has been cleaned by steaming, without wearing a respirator, hose mask type only, and without having another person stationed at the manhole with a rope attached to the person entering the tank. Hobnailed shoes and metal tools are liable to create sparks and should not be used inside an empty tank.

(1) Small quantities of the material with which the tank car was loaded may remain in the "empty" tank car and when the vapors remaining therein are unstable it is permissible to add sufficient inert gas to render the vapors stable.

§ **74.596 Inspection of tank cars.** (a) Placarded loaded tank cars must be inspected by the carrier before acceptance at the originating points and when received in interchange to see that they are not leaking and that the air and hand brakes, journal boxes, and trucks are in proper condition for service.

(b) Empty tank cars previously containing a dangerous article tendered for movement or when received in interchange must have manhole covers, outlet valve reducers, outlet valve caps, outlet valve cap plugs, end plugs, and plugs or caps of other openings securely in their proper places; except that heat coil inlet and outlet pipes must be left open for drainage.

(c) Safety valves on tank cars must not be tested while these cars are loaded. Whenever test of safety valves or tank is due on a loaded car while in transit, unless the car is leaking or in a manifestly insecure condition, it must be forwarded to destination, carded on each side with a card exhibiting the following notice:

Safety valves
Overdue for test.
Tank

Moving under I. C. C. § 74.596 (c).

(1) Prompt reports of such movements, showing initials and numbers of cars, must be made by the railroad carding the cars to the Bureau of Explosives, 30 Vesey Street, New York City.

§ **74.597 Leading packages of acid or poisons.** (a) Whenever a car bearing the "Dangerous" placard is discovered in transit with packages in leaking condition, all unnecessary movement of the car must cease and at the first opportunity an examination must be made of the lading, and if practicable any broken or leaking packages of nitric or mixed acids should be removed promptly to prevent fire. Any acid or other corrosive liquid remaining on the car floor or on surrounding packages should be washed away with a plentiful supply of water, or if not available, cleaned up with a liberal application of sand or earth. Care should be exercised to prevent inhalation of gases liberated through the application of water; when employees are injured by acid or other corrosive liquid, the liquid should be washed off immediately by a liberal application of water.

(b) Cars which have contained arsenic, arsenate of lead, sodium arsenate, calcium arsenate, Paris green, calcium cyanide, potassium cyanide, sodium cynadie, or other poisonous articles, which show any evidence of leakage from packages must be thoroughly cleaned after unloading before cars are again placed in service.

(c) Leakage of dangerous articles is often accompanied by odors characteristic of the articles, and all available opportunities for noting such odors must be utilized in order that the source of leakage may be discovered and the leakage stopped, or the leaking package removed from the car, or the contents of tank cars transferred. If artificial light is necessary, only electric lights should be used. Leaking tank cars containing compressed gases should be switched to a location distant from habitation and highways and proper action taken for transferring contents under competent supervision.

(d) Cars containing leaking packages or leaking tank cars must be protected against ignition of liquid or vapors by flame of inspector's lanterns or torches, by burning fusees, by switch-lights, by switch-thawing flames, by fires on side of track, by hot coals from locomotives, or otherwise. All unnecessary movement of a car discovered in transit in leaking condition must cease until the unsafe condition is remedied.

(e) Radioactive materials—Poison class D. In event of breakage of container, wreck, fire, or unusual delay involving cars placarded "Dangerous—Class D Poison" as prescribed in § 74.541 (b) of this part, the car and any loose radioactive material must be isolated as far as possible from danger of human contact and no persons must be allowed to remain close to the car or contents needlessly until qualified persons are available to supervise handling. The shipper and the Bureau of Explosives should be notifiied immediately.

(1) Cars, buildings, areas, or equipment in which class D poisons have been spilled must not be again placed in service or occupied until decontaminated by qualified persons.

§ 74.598 **Inspection of cars at interchange.** (a) Cars containing explosives requiring explosives placards (see § 74.525 (a)), which are offered by connecting lines must be carefully inspected by the receiving line on the outside, including the roof; and, if practicable, the lading must also be inspected. These cars must not be forwarded until all discovered violations have been corrected.

(b) If the car shows evidence of, or if there is any reason to suspect that it has received rough treatment, the lading must be inspected and placed in proper condition before the car is permitted to proceed. When interchange occurs and inspection is necessary after daylight hours, electric flash lights should be provided. Naked lights must not be used.

(c) Shipments of explosives and other dangerous articles offered by connecting lines must comply with Parts 71-78, and the revenue waybill, freight bill, manifest of lading, card waybill, switching order, transfer slip tickets, or other billing, must bear label notation and placard indorsement prescribed by § 74.584 of this part.

(d) Cars containing packages of dangerous articles other than explosives should not be offered in interchange if packages are in leaking condition. If small leaks have developed in movement of tank cars to interchange, and where short movements are necessary to make delivery for unloading by consignee, and this movement may be safely made, the precautions prescribed by §74.594 of this part, must be observed.

§ 74.599 **Handling by electric railways and motor cars.** (a) Explosives, class A, as specified in §§ 73.53 to 73.87, must not be transported in any self-propelled car operated by electric or other motive power, if such car is carrying passengers.

(b) Dangerous articles other than explosives, and class B, and class C, explosives when transported in self-propelled motor cars, must be carried in a compartment of such cars in which there shall be no electrically operated apparatus, or electric circuits, other than circuits in conduits properly installed.

(c) When the motor car is used as a freight or baggage car and not as a passenger car, not more than 500 pounds net of explosives, or not exceeding 5,000 blasting caps or electric blasting caps, may be transported. The explosives must be placed in a "magazine" box made of sound lumber not less than 1 inch thick, covered on the exterior with metal, and provided with strong handles. This box must be plainly stenciled on the top, sides, and ends, in letters not less than 2 inches high, "EXPLOSIVES —DANGEROUS—HANDLE CAREFULLY." The box must be provided with strong hinges and with a lock for keeping it securely closed. Vacant space in the box must be filled with a cushioning material such as sawdust or excelsior, and the box must be properly stayed to prevent movement within the car.

(d) Explosives may be transported in a trailer or other closed car and must be securely blocked, braced and stayed so as to prevent movement during transit, and other freight must not be permitted to fall on or slide against such shipments.

(e) Trailer cars or other cars not occupied by a representative of the carrier must bear the standard placards as prescribed in this part.

(f) Explosives and other dangerous articles must not be loaded, and transported together, except as permitted by the loading and storage chart, § 74.538 of this part.

(g) All the requirements of Parts 71 to 78 as to packing, marking, labeling, description, certification and waybilling, must be complied with for all shipments of explosives or other dangerous articles transported by electric railways or other self-propelled motor car lines engaged in interstate or foreign commerce.

§ 74.600 **In case of a wreck.** (a) Details involving the handling of explosives and other dangerous articles in the event of a wreck may be found in Bureau of Explosives' Pamphlet No. 22 covering "Recommended Practice for Handling Collisions and Derailments Involving Explosives, Gasoline and Other Dangerous Articles."

(b) Whenever a car placarded "Explosives" is involved in an accident or wreck it must be opened and contents examined, and whenever opened for any purpose inspection must be made of the packages of explosives as soon as practicable without unnecessary disturbance of lading, to see that they are properly loaded and stayed and in good condition. Upon the discovery of leaking or broken packages they must be carefully removed to a safe place. Loose powder or other explosives must be swept up and carefully removed. If the floor is wet with nitroglycerin the car is unsafe to use, and a representative of the Bureau of Explosives should be immediately called to superintend the thorough mopping and washing of the floor with a warm, saturated solution of concentrated lye or sodium carbonate. If necessary, the car must be placed on an isolated siding and proper notice given.

(c) Whenever a car placarded "Dangerous—Class D Poison" is involved in a wreck resulting in damage to any container of radioactive material, such container should be isolated as far as practicable from human contact. The shipper and the Bureau of Explosives must be notified immediately. Cars, building, equipment, or areas in which radioactive materials have been spilled must not be again placed in service or occupied until it has been determined that no dangerous contamination exists.

§ 74.601 **Calcium hypochlorite compounds, dry, involved in fires.** (a) Calcium hypochlorite compounds, dry, packed in metal drums when involved in cars where fire has occurred from any cause must be held at least five days before forwarding. Drums showing evidence of spontaneous heating or stress from internal pressure must not be reshipped.

§ 74.602 **Placarded cars involved in fires.** (a) Placarded cars which have been on fire due to hot journals or any other cause shall not be transported, except to the extent necessary to facilitate fire fighting, until it has been determined that there is no fire remaining within the car.

FOR INFORMATION ONLY

PART 75—REGULATIONS APPLYING TO CARRIERS BY RAIL EXPRESS

Subpart A—Regulations Governing Transportation of Explosives by the Railway Express Agency, Incorporated Passenger or Express Train Service

Sec.

75.650 Purpose of regulations in Parts 71-78.
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§75.675 Explosives via Railway Express Agency, Inc.

§ 76.650 **Purpose of regulations in Parts 71-78.** (a) To promote the uniform enforcement of law and to minimize the dangers to life and property incident to the transportation of explosives and other dangerous articles, by rail express carriers engaged in interstate or foreign commerce, Parts 71-78 are prescribed to define these articles for rail express transportation purposes, and to state the precautions that must be observed by the carrier in handling them while in transit. It is the duty of each such carrier to make the prescribed regulations effective and to thoroughly instruct employees in relation thereto.

§ 75.651 **Acceptable articles.** (a) Explosives and other dangerous articles, except such as will not be accepted, may be offered for transportation to rail express carriers engaged in interstate or foreign commerce and transported, provided they are in proper condition for transportation and are certified that the regulations in Parts 71-78 have been complied with, and provided their method of manufacture, packing and storage, so far as they affect safe transportation, are open to inspection by a duly authorized representative of the initial carrier or of the Bureau of Explosives. Shipments of explosives or other dangerous articles not in proper condition for transportation, or loaded or stayed as required, or certified as to proper packing, marking and description as required in Parts 71-78 must not be accepted for transportation or transported.

§ 75.652 **Application.** (a) Parts 71-78 apply to all shipments of explosives and other dangerous articles as defined in Part 73 including carriers' material and supplies.

§ 75.653 **Labels.** (a) Labels prescribed by the Commission's regulations, Part 73, must be applied to rail express shipments, unless exempt from Parts 71-78, and in addition the shipper must certify to compliance with the regulations by writing, stamping, or printing his name underneath the certificate printed thereon.

(b) Carriers must keep on hand an adequate supply of labels. Lost or detached labels must be replaced from information given on the waybill or from information on the package.

§ 75.654 **Receipts.** (a) A receipt upon the form prescribed by the originating rail express carrier must be issued to the shipper for each express shipment of explosives or other dangerous articles accepted for transportation. Before a receipt is isued, the shipper must apply the label prescribed in Part 73 to each package containing any article requiring a label under Parts 71-78.

(b) Each receipt must show the proper and definite name of commodity, as listed in § 72.5, and the color or kind of label applied to the package if any is required. Abbreviations must not be used.

§ 75.655 **Protection of packages.** (a) In handling packages containing explosives or other dangerous articles, care must be taken to prevent them from falling or from being broken. They must not be thrown, dropped, or rolled. Packages bearing the marking "This Side Up" or "This End Up" as required by Part 73 must be so handled and loaded.

(b) Packages protected by labels must be so loaded that they cannot fall to the car floor and in such manner that other freight cannot fall onto or slide against them.

(c) Unless sealed cars are equipped with a suitable guard or screen to prevent the lading coming in contact with hot steam pipes, or heat exits used in electrically-heated equipment, packages containing explosives or other dangerous articles must not be transported in them.

(d) Shipments of explosives or other dangerous articles, except poisons and nonflammable compressed gases, when transported in passenger carrying trains, should be loaded in the car occupied by an express employee or in connecting cars to which an express employee has access through end doors, and in a place that will permit their ready removal in case of fire. They must not be loaded in cars or stored in stations near steam pipes or other sources of heat. Explosives, flammable liquids (red label), and flammable compressed gases (red gas label) must not be loaded, transported, or stored in cars or stations equipped with lighted heaters or where open-flame lights or stoves or electric devices having exposed heating coils are used. No placards are required on such cars when occupied by an express employee. Shipments bearing poison label, when practicable, should be loaded in sealed cars; when loaded in cars occupied by messenger, care should be taken to prevent any contents sifting or leaking from containers.

(e) When an express or baggage car containing any package requiring a label prescribed by Part 73 is not occupied by an express employee, or is not a connecting car to which an express employee has access through an end door, and the car is handled in a passenger, mixed, or freight train, the proper placards must be attached thereto as required by Part 74 for the transportation of such articles by rail freight.

(f) Packages containing dangerous articles, as defined by Part 73, that are loaded in sealed cars for express movement from the point of origin, must be loaded in a place that will permit of their ready removal in case of fire, wreck, or unloading, and near the car door, if possible.

(g) Not to exceed 10 gas identification sets may be transported in any car at any time.

(h) It is important to prevent contact of contents of packages bearing either yellow or white corrosive liquid labels with combustible substances, such as sawdust, shavings, or sweepings, that may be present in express cars. The space should be swept or cleaned.

(i) Unless they are leaking, or in a manifestly insecure condition, packages of dangerous articles other than explosives in transit must be forwarded to destination and report made of any violation observed. Leaking packages must be reconditioned or repaired promptly and forwarded to destination.

(j) A container of radioactive material bearing red label must not be placed in cars, depots or other places closer than 3 feet to an area which may be continuously occupied by passengers, employees, or shipments of animals. When more than one such container is present, the distance from occupied areas must be computed from the table in subparagraph (2) of this paragraph by adding the number of units shown on labels on the containers.

(1) In a combination car carrying passengers and/or express shipments, a container of radioactive material must not be placed closer than 3 feet to the dividing partition. For more than one such container the distance must be computed by method described in subparagraph (2) of this paragraph.

(2) A container of radioactive material, red label, must not be placed closer than 15 feet to any package containing undeveloped film. If more than one such container is present, the distance must be computed from the table in this subparagraph by adding the number of units shown on the labels on the packages.

Table

Total number of units	Minimum distance in feet to nearest undeveloped film	Distance in feet to area that may be continuously occupied by passengers or employes	Distance in feet from dividing partition by a combination car
1 to 10.......	15	3	3
11 to 20.......	20	4	4
21 to 30.......	25	5	5
31 to 40.......	30	6	6

NOTE 1: The distance in the table must be measured from the nearest point of the radioactive container or containers.

NOTE 2: 1 unit equals 1 milliroentgen per hour at 1 meter for hard gamma radiation or the amount of radiation which has the same effect on film as 1 mrhm. or hard gamma rays of radium filtered by ½ inch of lead.

(3) Not more than 40 units of radioactive material (red label) shall be transported in any car or stored in any location at one time.

(4) All containers of radioactive material (red label) must be carried by the handles when handles are provided.

(5) Radioactive materials (class D poisons) must not be loaded in the same car with samples of explosives.

(6) If for any reason, a package containing radioactive material (red label) would otherwise remain in the same building for a period longer than 24 hours, it must be moved to a different location after each 24 hours.

(7) In case of fire, wreck, breakage or unusual delay involving any shipment of radioactive material, the package or material should be segregated as far as possible from human contact. The shipper and the Bureau of Explosives should be immediately notified. In case of breakage of a package containing radioactive material and when it appears likely that the inside container may have been damaged, great care must be exercised to prevent contact with, inhalation, or any other means of the radioactive material entering the body. Cars, buildings, areas, or equipment in which class D poisons have been spilled must not be again placed in service or occupied until decontaminated by qualified persons.

§ 75.656 **Removal at destination.** (a) Shipments of explosives and other dangerous articles as defined by Part 73 which cannot be delivered within 48 hours after arrival at destination, Saturday, Sunday, and holidays not included, or shipments which are refused by the consignee, must be promptly disposed of (1) by return to the shipper, if in proper shipping condition, or (2) by storage, provided a suitable storage place for such articles is available off the carrier's property, or (3) by sale, or (4) when necessary to safety, by destruction; Provided, That charged electric batteries may be held for 30 days after arrival at destination, pending delivery or disposition.

§ 75.657 **Waybills.** (a) The waybill or delivery sheet when used as a waybill, or other billing issued in lieu thereof, and the transfer sheet, or interchange record used for transferring such shipments to a connecting carrier, must properly describe the articles by name as shown in § 72.5, and show color or kind of label applied. Abbreviations must not be used.

§ 75.658 **Connecting line shipments.** (a) Shipments of dangerous articles offered by connecting express or other transportation lines must comply with Parts 71-78.

§ 75.659 **Astray shipments.** (a) Any astray shipment of dangerous articles must be forwarded promptly to destination, if known, provided a careful inspection shows the package to be in proper condition for safe transportation. If the package is not labeled and the exact nature of the contents is unknown, the red label must be applied.

§ 75.660 **Violations and accidents or fires must be reported.** (a) Violations and accidents or fires must be reported promptly by the express carrier to the Bureau of Explosives, 30 Vesey Street, New York 7, N. Y., as follows:

(1) Serious violations of Parts 71-78.

(2) Facts relating to leaking or broken containers.

(3) Accidents or fires in connection with the transportation or storage on express or railway property of explosives or other dangerous articles. (See § 74.588.)

SUBPART A—REGULATIONS GOVERNING TRANSPORTATION OF EXPLOSIVES BY THE RAILWAY EXPRESS AGENCY, INCORPORATED, IN PASSENGER OR EXPRESS TRAIN SERVICE.

§ 75.675 **Explosives via Railway Express Agency, Inc.** (a) Except as provided in this section, shipments of explosives may be tendered for transportation by Railway Express Agency in passenger or express train service only when the Commission finds that an emergency requires such expedited movement. Emergency shipments shall be subject to regulations which the Commission deems advisable or necessary in the interest of the public in each emergency:

Exception No. 1: Samples of explosives for laboratory examination, fireworks or other similar authorized explosives may continue to be transported in passenger or express train service, subject to the published regulations (See §§ 72.5 and 73.86 (d)).

Exception No. 2: In time of war or of national emergency proclaimed by the President, shipments of explosives by, for or to the Armed Forces of the United States of America may be tendered for transportation in passenger or express train service when such shipments comply with the special regulations furnished to the Department of Defense, Railroads and the Railway Express Agency, Incorporated.

FOR INFORMATION ONLY

PART 76—REGULATIONS APPLYING TO RAIL CARRIERS IN BAGGAGE SERVICE

Sec.

76.700 Purpose of regulations in Parts 71-78.
76.701 Application.
76.702 Dangerous articles.
76.703 Acceptable articles.
76.704 Labels.
76.705 Placards.
76.706 Handling of packages.
76.707 Reporting violations and accidents or fires.

§ **76.700 Purpose of regulations in Parts 71-78.** (a) To provide for the safe transportation of dangerous articles in rail baggage service on passenger-carrying trains of carriers engaged in interstate or foreign commerce, the following regulations are prescribed to define these articles for rail baggage transportation purposes, and to state the precautions that must be observed by the carrier in handling them while in transit.

§ **76.701 Application.** (a) Parts 71-78 apply to all shipments in rail baggage service of dangerous articles as prescribed in this part. Shipments of explosives, other than small arms ammunition, or any dangerous articles, except as provided in this part, must not be accepted for transportation in rail baggage service. The Commission will make provision as occasion and safety may require for dangerous articles other than those described in this part. Carriers engaged in interstate or foreign commerce must make the regulations in this part effective and must provide for the thorough instruction of their employees.

NOTE 1: Explosives or other dangerous articles, consisting of carrier's materials and supplies such as are acceptable for rail express transportation, may be transported in baggage cars when packed, marked, and labeled as prescribed by regulations for rail express shipments in Part 75.

§ **76.702 Dangerous articles.** (a) No dangerous article described by Parts 71-78 shall be accepted for transportation or transported in rail baggage service except as provided for in § 76.703 of this part and which must be packed, marked and labeled as required by Part 73.

§ **76.703 Acceptable articles.** (a) The following articles ticles may be transported in rail baggage service under this part:

(b) Compressed gases:

Dichlorodifluoromethane	Green gas label	In cylinders not exceeding 12 x 51 inches, and with pressure not exceeding 300 pounds at 70° F.
Dichlorodifluoromethane-dichlorotetrafluoroethane mixture	Green gas label	
Dichlorodifluoromethane-trichlorotrifluoroethane mixture	Green gas label	
Dichlorodifluoromethane-monochlorodifluoromethane mixture	Green gas label	
Dichlorodifluoromethane-trichloromonofluoromethane-monochlorodifluoromethane mixture	Green gas label	
Hydrogen	Red gas label	
Oxygen	Green gas label	
Anhydrous ammonia	Green gas label	In cylinders not exceeding 4½ by 22 inches.
Chlorine	Green gas label	
Ethylene	Red gas label	
Liquefied carbon dioxide	Green gas label	
Liquefied petroleum	Red gas label	
Methyl chloride	Red gas label	
Nitrous oxide	Green gas label	
Oxygen	Green gas label	
Sulfur dioxide	Green gas label	

(1) Compressed gases must be shipped in metal cylinders complying with specifications and regulations as prescribed for freight shipments.

(c) Motion-picture films, yellow label. In containers as prescribed by paragraphs (e) to (g) of this section.

(d) Mine -rescue equipment. Cylinders of compressed gas for mine rescue or medical work may be shipped when packed with other equipment pertaining to such work; cylinders not over 4½ by 22 inches may be shipped when packed in traveling bags, suitcases, trunks, or other suitable outside containers. When so packed, the prescribed label must be placed on each outside container.

(e) Flammable motion-picture films must be packed in spark-proof metal cases or trunks complying with spec. 32A, 32B, or 32C. Not more than 12,000 feet of standard width (1⅜ inches wide), 12 reels of approximately 1,000 feet each, or equivalent thereof, or more than 3 reels of stereoscopic film (2½ inches wide and approximately 1,500 feet each, may be packed in one such outside container; or as follows:

(1) In outside wooden boxes, spec. 15A, 15B, 15C, or 16A, provided each reel is placed in a tightly closed inside metal container. The gross weight of such a package must not exceed 80 pounds. Boxes must be equipped with handles, and covers securely fastened by metal hasp and staple with a strong lock or other efficient device.

(f) When slow-burning (nonflammable) motion picture films are packed in the same outside containers with flammable motion-picture films, the outside packages must bear the yellow label, and the total contents of the outside container must not exceed the quantity or gross weight permitted for flammable films. (See paragraph (e) of this section.)

(g) Packages of motion-picture films with advertising matter attached to the outside container must not be offered or accepted for transportation. Shippers desiring to include advertising matter with their shipments of motion-picture films must place the advertising matter inside the outside box containing the films.

§ **76.704 Labels.** (a) All packages containing samples of explosives for laboratory examination, special fireworks and other dangerous articles for which labels are prescribed by Part 73, must be conspicuously labeled by the shipper. Labels should be applied when practicable to that part of the package bearing the consignee's name and address, or baggage check. The shipper must certify to complicance with Parts 71-78 by writing, stamping, or printing his name underneath the certificate printed thereon. Shippers must furnish and attach labels prescribed for their shipments.

(b) Carriers must keep on hand an adequate supply of labels. Lost or detached labels must be replaced.

§ **76.705 Placards.** (a) Placards ordinarily used to indicate the presence in cars of flammable articles will not be required on baggage cars in charge of a railroad employee and moving in passenger trains, or on electric or gasoline motor cars in charge of an employee of the carrier, and which are run independently of cars carrying passengers. (See § 74.543 for placarding of cars not occupied by carrier's employee.)

§ **76.706 Handling of packages.** (a) In handling packages containing dangerous articles, care must be taken to prevent them from falling or from being broken. They must not be thrown, dropped, or rolled.

(b) Packages containing dangerous articles when transported in baggage service in passenger-carrying trains must be loaded in the car occupied by a railway employee, and in a place that will permit their ready removal in case of fire. They must not be loaded in cars nor stored in stations near steam pipes or other sources of heat.

(c) The originating carrier, when a shipment is offered to it that is known to contain dangerous articles as defined by Parts 71-78, must see that the packages are marked and labeled as prescribed in Part 73.

(d) Shipments of dangerous articles offered by connecting transportation lines must comply with the regulations in Parts 71-78.

(e) An astray shipment of dangerous articles or a shipment made in violation of Parts 71-78 without the knowledge of the carrier, must be forwarded promptly to destination, if known, provided a careful inspection shows the package to be in proper condition for safe transportation.

(f) Unauthorized persons must not be allowed to have access to dangerous articles in transit at any time while such articles are in the custody of the carrier.

§ **76.707 Reporting violations and accidents or fires.** (a) Serious violations of the regulations in Parts 71-78, facts relating to leaking or broken containers, and accidents or fires in connection with the transportation or storage on railway property of explosives or other dangerous articles, must be reported promptly by the rail carrier in baggage service to the Bureau of Explosives, 30 Vesey Street, New York, N. Y. (See § 74.588.)

PART 77—REGULATIONS APPLYING TO SHIPMENTS MADE BY WAY OF COMMON, CONTRACT, OR PRIVATE CARRIERS BY PUBLIC HIGHWAY

Subpart A—General Information and Regulations

Sec.

77.800 Purpose of regulations in Parts 71-78.
77.801 Scope of Parts 71-78.
77.802 Application of Parts 71-78.
77.803 Import shipments by domestic carriers by motor vehicle.
77.804 Export shipments by domestic carriers by motor vehicle.
77.805 Canadian shipments.
77.806 United States Government shipments.
77.807 Improperly packed or damaged shipments in transportation.
77.808 Connecting carrier shipments.
77.809 Carrier's material and supplies.
77.810 Vehicular tunnels.
77.811 Astray shipments.
77.812 Containers required.
77.813 Inefficient containers.
77.814 Accidents to be reported.
77.815 Labels.
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77.817 Shipping papers.
77.818 Receipts.
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77.820 Waybills, manifests, etc.
77.821 Explosives or other dangerous articles forbidden or limited for transportation.
77.822 Acceptable articles.
77.823 Marking on motor vehicles and trailers.

Subpart B—Loading and Unloading

77.834 General requirements.
77.835 Explosives.

Sec.

77.836 Nonexplosive material.
77.837 Flammable liquids.
77.838 Flammable solids and oxidizing materials.
77.839 Corrosive liquids.
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Subpart C—Loading and Storage Chare of Explosives and Other Dangerous Articles

77.848 Loading and storage chart of explosives and other dangerous articles.

Subpart D—Vehicles and Shipments in Transit; Accidents

77.853 Transportation and delivery of shipments.
77.854 Disabled vehicles and broken or leaking packages; repairs.
77.855 Accidents; explosives.
77.856 Accidents; flammable liquids.
77.857 Accidents; flammable solids and oxidizing materials.
77.858 Accidents; corrosive liquids.
77.859 Accidents; compressed gases.
77.860 Accidents; poisons.

Subpart E—Regulations Applying to Explosives or Other Dangerous Articles on Motor Vehicles Carrying Passengers for Hire

77.870 Regulations for passenger carrying vehicles.

Prescribed under authority of the Transportation of Explosives Act of March 4, 1921, 41 Stat. 1444, 1445, for regulations applying to common carriers by motor vehicle, and under authority of the Interstate Commerce Act, Part II, sec. 204 (a) (2), for regulations applying to contract carriers by motor vehicle.

Authority: §§ 77.800 to 77.870 issued under sec. 204, 49 Stat. 546, as amended, sec. 835, 62 Stat. 739; 49 U. S. C. 304, 18 U. S. C., Sup. 835.

The regulations in Parts 71-78 are applicable to every common, contract, and private carrier of property subject to the regulatory provisions of Section 835 Public Law 772, 80th Congress (62 Stat. 738), and/or Part II of the Interstate Commerce Ace.

Private carriers by public highway subject to Parts 71-78 are prohibited from transporting any explosive or other dangerous article unless the article is properly described by name in papers required by Parts 71-78 to accompany every shipment of such article; and that every such article must be packed and marked and in proper condition for transportation according to the regulations in Parts 71-78.

NOTE 1: Because of the present emergency and until further order of the Commission, the following regulations shall apply to transportation of flammable liquids by private carriers of property in interstate or foreign commerce:

All regulations heretofore applying to common or contract carriers by motor vehicle shall apply to such private carriers, except:

Cargo tanks of tank motor vehicles constructed previous to June 15, 1943, may be continued in service if maintained in safe operating condition and sufficiently frequent inspections are maintained to determine compliance with all requirements as specified in this Note.

Any defect or deficiency, due to accident or otherwise, that is likely to cause serious hazard must be corrected before any such tank is continued in or returned to service; see, however, § 77.856 of this part.

Requirements applying to tests of tanks, and provisions for markers thereon except that indicating the flammable nature of the cargo, are waived.

Outages for shipments shall be those provided for by Part 73, except that filling of tanks to outage markers already incorporated in tanks, having due regard for safety in the transportation of the flammable liquids, need not be changed.

Section 77.815 of this part, labels, and § 77.819 of this part, certification of packages, need not be complied with by such private carriers, except as to packages transferred from one carrier to another.

SUBPART A—GENERAL INFORMATION AND REGULATIONS

§ 77.800 **Purpose of regulations in Parts 71-78.** (a) To promote the uniform enforcement of law and to minimize the dangers to life and property incident to the transportation of explosives and other dangerous articles, by common and contract carriers, by motor vehicle engaged in interstate or foreign commerce, the regulations in Parts 71-78 are prescribed to define these articles for motor vehicle transportation purposes, and to state the precautions that must be observed by the carrier in handling them while in transit. It is the duty of each such carrier to make the prescribed regulations effective and to thoroughly instruct employees in relation thereto.

§ 77.801 **Scope of regulations in Parts 71-78.** (a) Explosives and other dangerous articles, except such as may not be accepted and transported under Parts 71-78, may be accepted and transported by common and contract carriers by motor vehicle engaged in interstate or foreign commerce, provided they are in proper condition for transportation and are certified as being in compliance with Parts 71-78, and provided the method of manufacture, packing, and storage, so far as they affect safety in transportation, are open to inspection by a duly authorized representative of the initial carrier or of the Bureau of Explosives. Shipments of explosives or other dangerous articles not in proper condition for transportation, or loaded or stayed as required, or certified as to proper packing, marking and description as required in Parts 71-78, must not be accepted for transportation or transported.

§ 77.802 **Application of regulations in Parts 71-78.** (a) Parts 71-78 apply to all common and contract carriers by motor vehicle transporting explosives and/or other dangerous articles as defined by Interstate Commerce Commission "Regulations for Transportation of Explosives and Other Dangerous Articles by Land and Water in Rail Freight, Express and Baggage Services and by Motor Vehicle (Highway) and Water." When shipments are accepted by motor vehicle for further transportation by rail express (see also paragraph (c) of this section), rail baggage (see also paragraph (d) of this section), rail freight or by water on board vessel, they must, in addition to Parts 71-78, comply with the applicable regulations for the service by which they are to be transported.

(b) The regulations prescribed by the Commandant of the Coast Guard governing the transportation of "Explosives or Other Dangerous Articles on Board Vessels" also include combustible liquids and hazardous articles.

(c) The fifth column of the Commodity List, § 72.5, indicates the maximum quantity of an article that may be accepted for transportation by rail express or that the article is not acceptable for transportation by rail express.

(d) The mark Ø preceding an article in the Commodity List § 72.5, indicates that the article may be accepted for rail baggage transportation. All articles not so marked are not acceptable for rail baggage transportation.

§ 77.803 **Import shipments by domestic carriers by motor vehicles.** (a) Import shipments of explosives and other dangerous articles offered in the United States in original packages for transportation by carriers by motor vehicle must comply with all requirements of Parts 71-78. Except for shipments from Canada conforming with §73.8, the importer must furnish with the order to the foreign shipper, and also to the forwarding agent at the port of entry, full and complete information as to the packing, marking, labeling, and other requirements, as prescribed in Parts 71-78, and the forwarding agent must file with the initial carrier in the United States a properly certified shipping order or other shipping papers as prescribed in Parts 71-78.

(b) Import shipments transferred in port areas by motor vehicle: Except for the requirements of §§ 77.817 and 77.823, the provisions of Parts 71-78 do not apply to such transportation by motor vehicle as may be necesesary to effect transfer of import shipments from place of discharge to other places within the same port area or delivery to a water carrier within the same port area (including continguous harbors). Further transportation of such import shipments by connecting water carrier shall be subject to the regulations prescribed by the Commandant of the Coast Guard.

§ 77.804 **Export shipments by domestic carriers by motor vehicle.** (a) Explosives and other dangerous articles authorized to be exported from the United States when packed, marked, labeled, and described, in accordance with rules and regulations in force at destination ports, must not be offered to any common or contract carrier by motor vehicle for domestic transportation unless in full accordance with Parts 71-78.

(b) Export shipments transferred in port areas by motor vehicle: Except for the requirements of §§ 77.817 and 77.823, the provisions of Parts 71-78 do not apply to such transportation by motor vehicle as may be necessary to effect transfer of export shipments from place of shipment to other places within the same port area or delivery to a water carrier within the same port area (including contiguous harbors). Further transportation of such export shipments by connecting water carrier shall be subject to the regulations prescribed by the Commandant of the Coast Guard.

§ 77.805 **Canadian shipments.** (a) Explosives or other dangerous articles which are packed, marked, labeded, and loaded, in conformity with the regulations of the Board of Transport Commissioners for Canada, may be accepted and carried by carriers from point of entry in the United States to their destination in the United States or through the United States en route to a point in Canada.

NOTE 1: Because of the present emergency and until further order of the Commission, compressed gas cylinders 40 inches in length and 8 inches in diameter, charged with not more than 40 pounds of carbon dioxide or when charged with nitrogen not in excess of 2,000 pounds per square inch, and shipped by or to the Canadian Department of National Defense in accordance with Board of Transport Commissioners for Canada Order No. 76253 dated March 10, 1951, may be shipped to destinations in the United States or through the United States to points in Canada.

§ 77.806 **United States Government shipments.** (a) Shipments of explosives or other dangerous articles offered by or consigned to the Departments of the Army, Navy, and Air Force of the United States Government, must be packed, including limitations of weight, in accordance with the regulations in Part 73 or in containers of equal or greater strength and efficiency as required by their regulations.

(b) Shipments of radioactive materials, made by the Atomic Energy Commission, or under its direction or supervision, which are escorted by personnel specially designated by the Atomic Energy Commission, are exempt from the regulations in Parts 71-78.

§ 77.807 **Improperly packed or damaged shipments in transportation.** (a) For the protection of the public against fire, explosion, or other, or further hazard, with respect to shipments of explosives or other dangerous articles offered for transportation or in transit by any common or contract carrier by motor vehicle, such carrier shall make immediate report to the Bureau of Explosives, 30 Vesey Street, New York, N. Y., for handling, any of the following emergency matters coming to their attention (see also §§ 77.853 to 77.870 for handling shipments in transit):

(1) Instances of packages of explosives or other dangerous articles discovered in transit not properly prepared for transportation in accordance with applicable regulations in Parts 71-78.

(2) Motor carrier accidents involving damage to container of explosives or other dangerous articles to such a degree as to necessitate repacking of the articles. (See § 74.588.)

(3) Other like emergencies in which any common or contract carrier by motor vehicle is or is likely to become involved, or may offer aid at its command.

(4) This section shall in no respect excuse either shipper or carrier by motor vehicle for failure to exercise due care to prevent any departure from any regulation prescribed in Parts 71-78.

§ 77.808 **Connecting carrier** shipments. (a) Shipments of explosives or other dangerous articles offered by connecting transportation lines must comply with Parts 71-78.

§ 77.809 **Carrier's material and supplies.** (a) The regulations in Parts 71-78 apply to all shipments of explosives and other dangerous articles, icluding carrier's material and supplies.

§ 77.810 **Vehicular tunnels.** (a) Nothing contained in Parts 71-78 shall be so construed as to nullify or supersede regulations established and published under authority of State statute or municipal ordinance regarding the kind, character, or quantity of any explosive or other dangerous article permitted by such regulations to be transported through any urban vehicular tunnel used for mass transportation.

§ 77.811 **Astray shipments.** (a) Any astray shipment of dangerous articles other than explosives must be forwarded promptly to destination, if known, provided a careful inspection shows the package to be in proper condition for safe transportation. If the package is not labeled and the exact nature of the contents is unknown, the red label must be applied.

§ 77.812 **Containers required.** (a) Containers required for explosives and other dangerous articles are prescribed in Part 73 Regulations Applying to Shippers.

§ 77.813 **Inefficient containers.** (a) The results of experience gained by examination of broken or leaking containers must be recorded by the Bureau of Explosives to the end that further use of any particular kind of container shown by experience to be inefficient, may be prohibited by the Commission.

§ 77.814 **Accidents to be reported.** (a) Fires or explosions occurring in connection with the transportation, or storage on carrier's property, of explosives or other dangerous articles, and leaking, broken, or seriously damaged containers, must be reported promptly by the highway carrier to the Commission. These reports are required to the end that further use of containers shown by experience to be inefficient may be prohibited by the Commission:

No. 3666

Report to
BUREAU OF SAFETY AND SERVICE
INTERSTATE COMMERCE COMMISSION
WASHINGTON, D. C.

FIRES, EXPLOSIONS, AND LEAKING, BROKEN, OR SERIOUSLY DAMAGED CONTAINERS

that can be attributed in whole or in part to the transportation or storage of explosives or other dangerous articles]

Submitted by ....
(Name of carrier—corporate or business name)

.........................., 19 ....
(Date)

Address ....
(Street and number) (City-town)

....
(State)

Common carrier, I. C. C. certificate No. ....

Contract carrier, I. C. C. permit No. ....

Date of accident or discovery of damage ....

....................................; place ....

Commodity and quantity ....

quantity destroyed ....

What marking or placards were on motor vehicle? ....

If a tank motor vehicle, what sign or other marking to indicate contents? ....

Show package markings:
- Name of contents ....
- I.C.C. Spec. No. ....
- Label ....
- Serial Nos. ....; Code Nos. ....
- If carboy, show box maker's name .... and whether straight sided .... or balloon shaped ....

Name and address of shipper ....

Name and address of consignee ....

T. L. or L. T. I. shipment ....

RESULTS OF ACCIDENT

[State whether in transportation or storage]

Number of persons injured ....; killed ....

Property loss:

Reporting-carrier's vehicle	$...........
Other vehicles	....
Reporting-carrier's cargo	....
Other cargoes	....
Other property (describe)	....
Total loss	....

Give all essential facts and details of handling (use additional sheet if necessary), stating: (1) Part of package damaged or leaking, and what was done to stop leak, (2) rate of leakage, (3) probable cause of fire, explosion, or leaking, broken, or seriously damaged container, (4) distance between source of ignition and point of leakage of flammable liquid or vapor, (5) description of package, packing or cushioning material, and method of loading and bracing in vehicle, (6) for tank motor vehicle, speed of vehicle, condition of highway, degree and elevation of curve, if any, (7) any defective condition of vehicle likely to contribute directly to accident, and (8) specification number, type, or other identifying description of tank, and date built, if shown.

Is this accident being reported to the Commission on

Form BMC-50? ....
(Yes or no)

This report is reqjuired by § 77.814 of regulations in Docket 3666.
Information furnished on this form will not be open to public inspection.

Signed ....

§ 77.815 **Labels.** (See § 73.405 to § 73.414 for description of labels. (a) Labels prescribed by the Commission's regulations, Part 73, must have been applied to shipments, unless exempt from Parts 71-78, and in addition the shipper must have certified to compliance with the regulations by writing, stamping, or printing his name underneath the certificate printed thereon or on the shipping papers.

(b) Labels and marking name of contents are not required on truckload quantities of dangerous articles, except class A, class C, or class D poisons when such shipments are unloaded by the consignee or his duly authorized agent from the motor vehicle in which originally loaded.

(1) Truckload shipments of chemical ammunition, explosive, containing poisonous gases, solids, or liquids, class A, class B or class C, or poisons class A, class B, class C or class D offered for transportation by, for, or to the Departments of the Army, Navy, and Air Force of the United States Government are exempt from labeling requirements when shipments are loaded or unloaded by the shipper or his duly authorized agent and

such shipments are accompanied by qualified personnel supplied with equipment to repair leaks or other container failure which will permit escape of contents.

(c) Except on class A, class C, or class D poisons, labels are not required on less-than-truckload shipments by motor vehicle by public highway when the articles are readily identifiable by reason of type of container or when the container is plainly marked to indicate its contents and;

(1) When the shipment is transported from origin to destination without transfer between vehicles and;

(2) When the shipper or its employees are in direct control, perform the loading, transporting and unloading.

(d) When it is known that subsequent shipments of these packages in less-than-truckload quantities will probably be made by the consignee, labels should be attached to the packages as would be required for less-than-truckload shipments.

(e) Carriers must keep on hand an adequate supply of labels. Lost or detached labels must be replaced from information given on waybill, manifest, memorandum, or other shipping paper.

(f) Samples will be furnished, on request, by the Bureau of Explosives, 30 Vesey Street, New York, N. Y.

(g) The carrier's name and stationery form number may be printed on the labels, in type not larger than 10 point, if placed within the red or black-line border and in the upper or lower corner of the diamond.

(h) Additional shipping information not inconsistent with Parts 71-78 may be shown by the shipper on a container of dangerous articles other than explosives if so desired, but no label or marking may be of a design, or form, or size, as may be confused with the label or marking required by Part 73.

§ **77.816 Marking on containers.** (a) Each package of explosives or other dangerous articles must show the name and address of the consignee. Whenever the transportation of any explosive or other dangerous article is to be exclusively by motor vehicle between points between which the articles are not to be transferred from one motor carrier to another, in either truckload or less-than-truckload lots, the individual packages need not be marked with the consignee's name and address.

§ **77.817 Shipping papers.** (a) Every motor carrier operating a motor vehicle transporting explosives or other dangerous articles shall require the driver of the vehicle to have in his possession, and the driver shall keep in his possession during the course of such transportation, a manifest, memorandum receipt, bill of lading, shipping order, shipping paper, or other memorandum setting forth the following information for each class of such article being transported: The shipping name, the total quantity by weight, volume, or otherwise as appropriate of each kind of explosive or other dangerous article, and the prescribed label when required for the outside container of such article. For shipments of blasting caps or electric blasting caps the shipper must, in addition show the number of caps in the shipment.

(1) Every carrier offering or delivering for rail transportation any loaded motor vehicle or any loaded motor vehicle trailer, semi-trailer, or container containing any shipment of an explosive or other dangerous article shall show on the shipping order, shipping paper, transfer sheet, or other billing issued in lieu thereof, in addition to the description of the vehicle or container, the proper and definite name of the commodity as shown in § 72.5 and the color or kind of label or kind of placards applied.

§ **77.818 Receipts.** (a) A receipt upon the form prescribed by the originating express carrier must be issued to the shipper for each express shipment of explosives or other dangerous articles accepted for transportation. Before a receipt is issued, the shipper must apply the label prescribed in Part 73 to each package containing any article requiring a label under Parts 71-78.

(b) Each receipt must show the proper and definite name of commodity, as listed in § 72.5, and the color or kind of label applied to the package if any is required. Abbreviations must not be used.

§ **77.819 Certificate.** (a) Except as provided in this section no motor carrier may accept for transportation or transport any class A or class B explosives, blasting caps or electric blasting caps in any quantity, or any dangerous articles requiring label as prescribed by Part 73, unless it be certified to him by the shipper's name inserted in the certificate on the label or by the following certificate over the written or stamped facsimile signature of the shipper or his duly authorized agent in the lower left-hand corner of the manifest, memorandum receipt, bill of lading, shipping order, shipping paper, or other memorandum:

> This is to certify that the above named articles are properly described, and are packed and marked and are in proper condition for transportation according to the regulations prescribed by the Interstate Commerce Commission.

(b) For the relief of shippers from multiplicity of certifications required for packages which may move by various means of transportation, shipments may be certified for rail, motor vehicle, water, or air transportation by adding to the certificate required on the shipping document "and the Commandant of the Coast Guard," or "and the Civil Air Regulations," as the case may be.

§ **77.820 Waybills, manifests, etc.** (a) The waybill, manifest, dispatch, memorandum receipts, bill of lading, transfer sheet, or interchange record, when prepared for shipments and used for transferring such shipments to a connecting carrier, must properly describe the articles by name as shown in § 72.5, and show the color or kind of label applied. (See § 77.817.)

§ **77.821 Explosives or other dangerous articles forbidden or limited for transportation.** (a) Nitroglycerin, desensitized liquid nitroglycerin or diethylene glycol, dinitrate, forbidden to common carriers. Liquid nitroglycerin desensitized liquid nitroglycerin or diethylene glycol dinitrate, except as defined in § 73.53 (e), may not be accepted for transportation or be transported by any common carrier by motor vehicle.

(b) Rejection of leaking containers of liquid nitroglycerin, desensitized liquid nitroglycerin or diethylene glycol dinitrate. Any individual container used for the transportation of liquid nitroglycerin, densensitized liquid nitroglycerin or diethylene glycol dinitrate, or any boot used therewith, found in such condition as to permit leakage, shall be discarded and shall not thereafter be repaired for further use.

(c) Explosives or other dangerous articles forbidden or limited for transportation. No motor carrier may accept for transportation or transport any explosive or other dangerous article listed in Commodity List (§ 72.5), as "forbidden" for transportation by all motor carriers; nor, if there be any prohibition or limitation regarding the transportation of any particular explosive or other dangerous article by a particular kind of motor carrier, may any such article be accepted for transportation or be transported by that kind of carrier, except as indicated in this part. (See § 77.870 of this part.)

(d) Leaking or damaged packages of high explosive must not be accepted for transportation or transported. Should any package of high explosive when offered for shipment show excessive dampness or be moldy or show outward signs of any oily stain or other indication that absorption of the liquid part of the explosive is not perfect, or that the amount of the liquid part is greater than the asborbent can carry, the package must be refused in every instance. The shipper must substantiate any claim that a stain is due to contact with material other than the liquid explosive ingredient of the explosive. In case of doubt the package must be rejected.

(e) Condemned or leaking dynamite; repacking. Condemned or leaking dynamite must not be repacked and offered for shipment unless the repacking is done by a competent person in the presence of or with the written consent of an inspector, or with the written authority of the chief inspector, of the Bureau of Explosives.

§ 77.822 **Acceptable articles.** (a) Any motor carrier may accept for transportation or transport any acceptable explosive or other dangerous articles listed in the Commodity List, § 72.5: Provided, however, That no provision of this section shall be so construed as to permit the acceptance or transportation of liquid nitroglycerin, densensitized liquid nitroglycerin or diethylene glycol dinitrate, other than as defined in § 73.53 (e), by any common carrier.

(b) Liquid nitroglycerin, densensitized liquid nitroglycerin or diethylene glycol dinitrate. Liquid nitroglycerin, desensitized liquid nitroglycerin or diethylene glycol dinitrate, other than as defined in § 73.53 (e), may be transported only by motor carriers other than common carriers in containers complying with specification MC200. No form of trailer may be attached.

§ 77.823 **Marking on motor vehicles and trailers.** (a) Every motor vehicle, other than tank motor vehicles, transporting any quantity of explosives, class A, poison gas, class A, or radioactive material, poison class D requiring red radioactive materials label; and every motor vehicle transporting 2,500 pounds gross weight or more of explosives, class B, flammable liquids, flammable solids or oxidizing materials, corrosive liquids, compressed gas, class B poisons, and tear gas, or 5,000 pounds gross weight or more of two or more articles of these groups shall be marked or placarded on each side and rear with a placard or lettering in letters not less than 3 inches high on a contrasting background as follows:

(1) Explosives, class A	EXPLOSIVES
(2) Explosives, class B	DANGEROUS
(3) Flammable liquid	DANGEROUS
(4) Flammable solid	DANGEROUS
(5) Oxidizing material	DANGEROUS
(6) Corrosive liquid	DANGEROUS
(7) Compressed gas	COMPRESSED GAS
(8) Poison gas, class A	POISON GAS
(9) Tear gas	DANGEROUS
(10) Poisons, class B	DANGEROUS
(11) Dangerous, class D poison	DANGEROUS—RADIOACTIVE MATERIAL

(b) Tank motor vehicles. Every tank motor vehicle used for the transportation of any flammable liquid, regardless of the quantity being transported, or whether loaded or empty, shall be conspicuously and legibly marked on each side and the rear thereof, in letters at least 3 inches high on a background of sharply contrasting color, optionally, as follows:

(1) With a sign or lettering on the motor vehicle, with the word "FLAMMABLE."

(2) With the common name of the flammable liquid being transported.

(3) With the name of the carrier or his trade-mark, when and only when such name or mark plainly indicates the flammable nature of the cargo.

(c) Tank motor vehicles. Every tank motor vehicle used for the transportation of any corrosive liquid, regardless of the quantity being transported, or whether loaded or empty, shall be conspicuously and legibly marked on each side and the rear thereof, in letters at least 3 inches high on a background of sharply contrasting color, optionally, as follows:

(1) The common name of the corrosive liquid being transported.

(2) A sign or lettering on the motor vehicle, with the word "ACID," or, when transporting corrosive liquids other than acids, the words "CORROSIVE LIQUD."

(d) Tank motor vehicles. Every cargo tank used for the transportation of any compressed gas, regardless of the quantity being transported, or whether loaded or empty, shall be conspicuously and legibly marked on each side and the rear thereof on a background of sharply contrasting color with a sign or lettering on the tank with words as appropriate "COMPRESSED GAS," or "FLAMMABLE COMPRESSED GAS" in letters at least 6 inches high; and in letters at least 2 inches high with the commonly accepted name, such as "ANHYDROUS AMMONIA," "CARBON DIOXTDE," "CHLORINE," LIQUEFIED PETROLEUM GAS," "NITROUS OXIDE," or "SULPHUR DIOXIDE."

(1) Every cargo tank shall be marked with the name of the motor carrier who owns the vehicle of which such tank forms a part; or, if the operator of the vehicle is not the owner, the name of the owner thereof.

(2) In addition to the markings hereinbefore required, there may be marked on any cargo tank the trademark appropriate to the commodity being transported therein; Provided, however, That no such marking shall be of such size and character as to render inconspicuous the required markings.

(3) No markings either required or permitted under the terms of this paragraph shall be in lieu of any other marking or markings required by the Commission.

(e) Tank motor vehicles. Every tank motor vehicle used for the transportation of any less dangerous poison, class B, regardless of the quantity being transported, or whether loaded or empty, shall be conspicuously and legibly marked on each side and the rear thereof, in letters at least 3 inches high, on a background of a sharply contrasting color, optionally, as follows:

(1) With a sign or lettering on the motor vehicle with the word "POISON."

(2) With the common name of the Class B poison being transported.

(f) Removal of signs or lettering. Every sign or lettering required by paragraph (a) of this section shall be removed from or covered on any motor vehicle to which it is attached or affixed when such motor vehicle is not transporting the article for which the sign is appropriate, except that no such sign or lettering is required to be removed or covered when such motor vehicle is used exclusively in the transportation of any article for which the sign or lettering is appropriate.

(g) Only one marking required. Whenever any motor vehicle is transporting more than one class of dangerous article for which signs or placards are required to be lettered on or affixed to any such motor vehicle, no more than one kind of sign, lettering, or placard need be displayed. The sign, lettering, or placard used shall be the one which, in the judgment of the motor carrier, designates the most dangerous article being transported.

SUBPART B—LOADING AND UNLOADING

NOTE: For prohibited loading and storage of explosives and other dangerous articles, see § 77.848 of this part.

§ 77.834 **General requirements.** (a) Containers secured in vehicle. Any tank, barrel, drum, or cylinder, not designed to be permanently attached to a motor vehicle, containing any flammable liquid, compressed gas, corrosive liquid, or poisonous article, shall be reasonably secured against movement within the motor vehicle by which it is being transported.

(b) No explosives or other dangerous articles on pole trailers. No explosive or other dangerous article may be loaded into or on or transported in or on any pole trailer.

(c) No smoking while loading or unloading. Smoking on or about any motor vehicle while loading or unloading any explosive, flammable liquid, flammable solid, oxidizing material, or flammable compressed gas is forbidden.

(d) Keep fire away, loading and unloading. Extreme care shall be taken in the loading or unloading of any explosive, flammable liquid, flammable solid, oxidizing material, or flammable compressed gas into or from any motor vehicle to keep fire away and to prevent persons in the vicinity from smoking, lighting matches, or carrying any flame or lighted cigar, pipe, or cigarette.

(e) Handbrake set while loading and unloading. No explosive or other dangerous article shall be loaded into or on, or unloaded from, any motor vehicle unless the handbrake be securely set and all other reasonable precautions be taken to prevent motion of the motor vehicle during such loading or unloading process.

(f) Use of tools, loading and unloading. No tools which are likely to damage the effectiveness of the closure of any package or other container, or likely adversely to affect such package or container, shall be used for the loading or unloading of any explosive or other dangerous article.

(g) Prevent relative motion between containers. Containers of explosives, flammable liquids, flammable solids, oxidizing materials, corrosive liquids, acids, compressed gases, and poisonous liquids or gases, must be so braced as to prevent motion thereof relative to the vehicle while in transit. Containers having valves or other fittings must be so loaded that there will be the minimum likelihood of damage thereto during transportation.

(h) Precautions concerning containers in transit; fueling road units. Reasonable care should be taken to prevent undue rise in temperature of containers and their contents during transit. There must be no tampering with such container or the contents thereof nor any discharge of the contents of any container between point of origin and point of billed destination. Discharge of contents of any container, other than a cargo tank, must not be made prior to removal from the motor vehicle. Nothing contained in this paragraph shall be so construed as to prohibit the fueling of machinery or vehicles used in road construction or maintenance.

(i) Tank motor vehicles attended, loading and unloading. Under no circumstances shall a tank motor vehicle be left unattended during the loading or unloading process. For the purpose of this part, the delivery hose, when attached to the motor vehicle, shall be deemed a part thereof.

(j) Prohibited loading combinations. In any single driven motor vehicle or in any single unit of a combination of motor vehicles, explosives and other dangerous articles shall not be loaded together if prohibited by loading and storage chart, § 77.848 of this part. This section shall not be so construed as to forbid the carrying of materials essential to safe operation of motor vehicles (see Motor Carrier Safety Regulations, Part 193).

(k) Access to mixed ladings. Flammable solids, oxidizing materials, or corrosive liquids, when transported on a motor vehicle with other lading not otherwise forbidden, shall be so loaded as to provide ready access thereto for shifting or removal.

§ 77.835 Explosives. (See also § 77.834 (a) to (k) of this part). (a) Engine stopped. No explosive shall be loaded into or on or be unloaded from any motor vehicle with the engine running.

(b) Care in loading, unloading, or other handling of explosives. No bale hooks or other metal tools shall be used for the loading, unloading, or other handling of explosives, nor shall any package or other container of explosives, except barrels or kegs, be rolled. No packages of explosives shall be thrown or dropped during process of loading or unloading or handling of explosives. Special care shall be exercised to the end that packages or other containers containing explosives shall not catch fire from sparks or hot gases from the exhaust tailpipe.

(c) Explosives on trucks or semitrailers; no other trailer. Any explosive other than liquid nitroglycerin, desensitized liquid nitrogen or diethylene glycol dinitrate, except as defined in § 73.53 (e), and forbidden explosives may be loaded into and transported on any truck or any semitrailer attached to a tractor, to which no form of trailer may be attached when so loaded.

(d) Explosives on trucks and full trailers. Any explosives other than liquid nitroglycerin, densensitized liquid nitroglycerin or diethylene glycol dinitrate, except as defined in § 73.53 (e), and forbidden explosives, may be loaded into and transported on any truck and a full trailer attached thereto provided that there shall be no more than one truck and one trailer comprising the combination.

(e) No sharp projections inside body of vehicles. No motor vehicle transporting any kind of explosive shall have on the interior of the body in which the explosives are contained, any inwardly projecting bolts, screws, nails, or other inwardly projecting parts likely to produce damage to any package or container of explosives during the loading or unloading process or in transit.

(f) Explosives vehicles, floors tight and lined. Motor vehicles transporting class A or claas B explosives shall have tight floors; shall have that portion of the interior in contact with the load lined with either non-metallic material or non-ferrous metals, except that the lining is not required for truck load shipments loaded by the Departments of the Army, Navy or Air Force of the United States Government provided the explosives are of such nature that they are not liable to leakage of dust, powder, or vapor which might become the cause of an explosion. The interior of the cargo space must be in good condition so that there will not be any likelihood of containers being damaged by exposed bolts, nuts, broken side panels or floor boards, or any similar projections.

(g) Blasting caps and/or electric blasting caps in same vehicle with other explosives. Blasting caps and/or electric blasting caps, without limitation as to quantity except as limited in paragraph (m) of this section, may be transported in the same motor vehicle with high explosives (dynamites and similar explosives) when the net weight of the high explosives (dynamites and similar explosives) does not exceed 5,000 pounds, as follows: The blasting caps and electric blasting caps must be packed in authorized I.C.C. specification outside shipping containers, or in prescribed inside I.C.C. packages in an outside box made of 1 inch lumber lined with suitable padding material not less than ½ inch thick or a box made of not less than 12 gauge sheet metal lined with plywood or other suitable material not less than ⅜ inch thick so that no metal is exposed. Hinged cover and fastening device are required on boxes. These boxes must be loaded in motor vehicle so that contents or box will be immediately accessible for removal and so that other containers in the motor vehicle will not fall on them or otherwise damage them during transit. Blasting caps or electric blasting caps when not packed in containers referred to above in this paragraph must be transported in containers as prescribed in spec. MC201. See paragraph (m) of this section for shipment of blasting caps with liquid nitroglycerin, desensitized liquid nitroglycerin or diethylene glycol dinitrate. Explosive projectiles with detonating fuzes assembled in place must not be transported unless shipped by, for, or to the Departments of the Army, Navy, and Air Force of the United States Government, or unless of a type approved by the Bureau of Explosives.

(h) Lading within body or covered, tailgate closed. Except as provided in paragraphs (g), (k), and (m) of this section, dealing with the transportation of liquid nitroglycerin, desensitized liquid nitroglycerin or diethylene glycol dinitrate, other than as defined in § 73.53 (e), all of that portion of the lading of any motor vehicle which consists of explosives shall be contained entirely within the body of the motor vehicle or within the horizontal outline thereof, without overhang or projection of any part of the load, and if such motor vehicle has a tailboard or tailgate, it shall be closed and secured in place during such transportation. Every motor vehicle transporting explosives must either have a closed body or have the body thereof covered with a tarpaulin, and in either event care must be taken to protect the load from moisture and sparks, except that subject to other provisions of these regulations, explosives other than black powder may be transported on flat-bed vehicles if the explosive portion of the load on each vehicle is packed in fire and water resistant containers or covered with a fire and water resistant tarpaulin.

(i) Explosives to be protected against damage by other lading. No motor vehicle transporting any explosive may transport as a part of its load any metal or other articles or materials likely to damage such explosive or any package in which it is contained, unless the different parts of such load be so segregated or secured in place in or on the motor vehicle and separated by bulkheads or other suitable means as to prevent such damage.

(j) Transfer of explosives en route. No class A or class B explosives shall be transferred from one container to another, or from one motor vehicle to another vehicle, or from another vehicle to a motor vehicle, on any public highway, street, or road, except in case of emergency. In such cases red electric lanterns, red emergency reflectors or red flags shall be set out in the manner prescribed for disabled or stopped motor vehicles. (See Motor Carrier Safety Regulations, Part 192 of this chapter). In any event, all practicable means, in addition to these hereinbefore prescribed, shall be taken to protect and warn other users of the highway against the hazard involved in any such transfer or against the hazard occasioned by the emergency making such transfer necessary.

(k) Loading requirements for liquid nitroglycerin, desensitized liquid nitroglycerin, or diethylene glycol dinitrate. Liquid nitroglycerin, desensitized liquid nitroglycerin, or diethylene glycol dinitrate, other than as defined in § 73.53 (e), may be accepted for transportation and transported only by motor carriers other than common carriers if it be loaded into or on a truck having the type of body specified in spec. MC200. No liquid nitroglycerin, desensitized liquid nitroglycerin or diethylene glycol dinitrate may be loaded directly above any other explosive glycol dinitrate may be loaded directly above any other explosive, or in any quantity in excess of 900 quarts on one motor vehicle or 10 quarts in any one individual container. Additional quantities of explosives, other than nitroglycerin, desensitized liquid nitroglycerin or diethylene glycol dinitrate, excepting any type of blasting or percussion cap or other detonating device, may be carried on such motor vehicle in a closed or covered bed or body which shall be firmly bolted or fastened above the lid of the compartment containing the nitroglycerin, desensitized liquid nitroglycerin or diethylene glycol dinitrate. In no case shall the net load be more than 7,500 pounds. (See paragraph (m) of this section and spec. MC201.

(l) Separation of tools and supplies for preparing charges. Motor vehicles transporting liquid nitroglycerin, desensitized liquid nitroglycerin or diethylene glycol dinitrate, may also transport the tools and supplies necessary for preparing and firing charges thereof: Provided, That such tools and supplies be properly secured in place so as to prevent their coming in contact with the body above specificed.

(m) Caps or other explosives. Any explosives, including desensitized liquid explosives as defined in § 73.53 (e), other than liquid nitroglycerin, desensitized liquid nitroglycerin or diethylene glycol dinitrate, transported on any motor vehicle transporting liquid nitroglycerin, desensitized liquid nitroglycerin or diethylene glycol dinitrate, shall be segregated; each kind from every other kind, and from tools or other supplies. Any percussion caps, detonators, blasting caps, or electric blasting caps, shall be carried either in a cloth container having individual pockets for each such cap, or by at least equally safe means. No greater number of any such caps shall be carried in the manner described than is necessary for use on any particular trip.

§ 77.836 Nonexplosive material. (a) No restrictions are prescribed in Parts 71-78 for the packing, handling, and transportation of material relating to ammunition for cannon, but containing no explosive or other dangerous article, such as cartridge cases, "dummy" or "drill" cartridges, etc., sand-loaded projectiles, sand-loaded bombs, empty projectiles, empty mines, empty bombs, solid projectiles, or empty torpedoes. Rotating bands should be protected against deformation by method of packing or loading.

§ 77.837 Flammable liquids. (See also § 77.834 (a) to (k) of this part). (a) Engine stopped. Unless the engine of the motor vehicle is to be used for the operation of a pump, no flammable liquid shall be loaded into or on or unloaded from any other motor vehicle than a tank motor vehicle with the engine running; and in any event care should be exercised to prevent ignition of the vapors from any such liquid.

(b) Bonding or grounding containers prior to and during transfers. For containers which are not in metallic contact with each other, either metallic bonds or ground conductors shall be provided for the neutralization of possible static charges prior to and during transfers of flammable liquids between such containers. Such bonding shall be made by first connecting an electric conductor to the container to be filled and subsequently connecting the conductor to the container from which the liquid is to come, and not in any other order. To provide against ignition of vapors by discharge of static electricity, the latter connection shall be made at a point well removed from the opening from which the flammable liquid is to be discharged.

§ 77.838 Flammagle solids and oxidizing materials. (See also § 77.834 (a) to (k) of this part.) (a) Lading within body or covered; tailgate closed; pick-up and delivery. All of that portion of the lading of any motor vehicle transporting flammable solids or oxidizing materials shall be contained entirely within the body of the motor vehicle and shall be covered by such body, by tarpaulins, or other suitable means, and if such motor vehicle has a tailboard or tailgate, it shall be closed and secured in place during such transportation: Provided, however, That the provisions of this paragraph need not apply to "pick-up and delivery" motor vehicles when such motor vehicles are used in no other transportation than in and about cities, towns, or villages.

(b) Articles to be kept dry. Special care shall be taken in the loading of any motor vehicle with flammable solids or oxidizing materials which are likely to become hazardous to transport when wet, to keep them from being wetted during the loading process and to keep them dry during transit. Special care shall also be taken in the loading of any motor vehicle with flammable solids or oxidizing materials, which are likely to become more hazardous to transport by wetting, to keep them from being wetted during the loading process and to keep them dry during transit. Examples of such dangerous materials are charcoal screenings, ground, crushed, or pulverized charcoal, and lump charcoal.

(c) Lading ventilation, precautions against spontaneous combustion. Whenever a motor carrier has knowledge concerning the hazards of spontaneous combustion or heating of any article to be loaded on a motor vehicle, such article shall be so loaded as to afford sufficient ventilation of the load to provide reasonable assurance against fire from this cause; and in such a case the motor vehicle shall be unloaded as soon as practicable after reaching its destination. Charcoal screenings, or ground, crushed, granulated, or pulverized charcoal, in bags, shall be so loaded that the bags are laid horizontally in the motor vehicle, and so piled that there will be spaces for effective air circulation, which spaces shall not be less than 4 inches wide; and air spaces shall be maintained between rows of bags. Bags shall not be piled closer than 6 inches from the top of any motor vehicle with a closed body.

(d) Loose or baled nitrate of soda bags. Loose or baled unwashed, empty bags, having contained nitrate of soda, may be transported in truckload lots only in motor vehicles, and such motor vehicles must have closed or covered bodies lined with paper; such shipments are required to be loaded by the shipper and to be unloaded by the consignee.

(e) Staying or blocking of packages of matches. Special care shall be exercised in the loading of packages containing "strike-anywhere" matches to prevent the shifting or jamming of any such package during transit. To this end, the packages shall be compactly loaded with the strongest dimensions of each box or other container loaded lengthwise of the motor vehicle.

(1) Smooth vehicle interior for matches. Unless strike-anywhere matches are contained in wooden outside boxes, special care shall be taken to provide that the inside surfaces of any motor vehicle into which such matches are to be loaded and with which surfaces the containers might come in contact, shall be smooth, without protrusions of any sort, such as bolts, nuts, sharp edges, or corners, etc., and there shall be provided for this purpose smooth wooden inner linings, if the interior of the motor vehicle is not otherwise smooth in accordance with this requirement.

(2) Matches not loaded next to red label articles. Matches of whatever character shall not be loaded next to packages protected by the red caution label.

(f) Nitrates listed in § 73.182 (b) must be loaded in closed or open type motor vehicles which must be swept clean and be free of any projections capable of injuring bags when so packaged. When shipped in open type motor vehicles the lading must be suitably covered. Ammonium nitrate, ammonium nitrate (organic coating), ammonium nitrate fertilizer, containing 90 percent or more ammonium nitrate with no organic coating, and guanidine nitrate must not be loaded in all metal vehicles, other than those of aluminum or aluminum alloys, of the closed type. (See § 77.823 (a) (4) and (a) (5).)

§ 77.839 **Corrosive liquids.** (See also § 77.834 (a) to (k) of this part.) (a) Nitric acid. In addition to the requirements set forth in paragraph (b) of this section, no carboy or other container of nitric acid shall be loaded above any container containing any other kind of material. The loading of carboys or other containers of nitric acid shall be limited to two tiers high.

(b) Carboys and frangible containers. In general, individual carboys and frangible containers of acids or other corrosive liquids, including charged electric storage batteries, shall, when loaded by hand, be individually loaded into and unloaded from any motor vehicle in which they are to be, or have been, transported. All reasonable precautions shall be taken to prevent, by all practicable means, the dropping of any such containers or batteries containing corrosive liquids. No such container or battery shall be loaded into a motor vehicle having an uneven floor surface. It shall be permissible to load on or transport in any motor vehicle any authorized carboys or frangible shipping containers, containing acids or other corrosive liquids, more than one tier high above any floor only if such carboys or other containers are boxed or crated, or are in barrels or kegs, as required by Parts 71-78, and only if such containers are so stacked that the weight of each tier above the first is entirely supported by the boxes, crates, barrels, kegs, or other authorized means of enclosing the carboys or frangible containers. Only so many tiers as may adequately be so supported without danger of crushing or breaking, shall be permitted. Means shall be provided to prevent by all practicable means, in all cases, the shifting of containers or batteries during transit. Nothing contained in this section shall be so construed as to prevent the use of cleats or other retaining means for the purpose of preventing shifting of containers or batteries. For the purposes of this section a false floor or platform, secured against relative motion within the body of the motor vehicle, shall be deemed to be a floor. (For recommendations for handling leaking or broken packages, see § 77.858 (a) of this part.)

(c) Storage batteries. In addition to the requirements set forth in paragraph (b) of this section, all storage batteries containing any electrolyte shall be so loaded, if loaded with other lading, that all such batteries will be protected against other lading falling onto or against them; and adequate means shall be provided in all cases for the protection and insulation of battery terminals against short circuits.

§ 77.840 **Compressed gases.** (See also § 77.834 (a) to (k) of this part.) (a) Floors or platforms essentially flat. Cylinders containing compressed gases shall not be loaded onto any part of the floor or platform of any motor vehicle which is not essentially flat; cylinders containing compressed gases may be loaded onto any motor vehicle not having a floor or platform only if such motor vehicle be equipped with suitable racks having adequate means for securing such cylinders in place therein. Nothing contained in this section shall be so construed as to prohibit the loading of such cylinders on any motor vehicle having a floor or platform and racks as hereinbefore described.

(1) Cylinders, horizontal. Cylinders containing compressed gases shall be loaded in a horizontal position unless packed in boxes or crates of such dimensions as to prevent their overturning, or unless loaded into racks securely attached to the motor vehicle, or unless so securely lashed in an upright position as to prevent their overturning.

(b) Portable tank containers containing compressed gases shall be loaded on motor vehicles only as follows:

(1) Onto a flat floor or platform of a motor vehicle.

(2) Onto a suitable frame of a motor vehicle.

(3) In either case, such containers shall be safely and securely blocked or held down to prevent movement relative to each other or to the supporting structure when in transit, particularly during sudden starts and stops and changes of direction of the vehicle.

(4) Requirements of subparagraphs (1) and (2) of this paragraph shall not be construed as prohibiting stacking of containers, provided the provisions of subparagraph (3) of this paragraph are fully complied with.

(c) Tanks complying with specification 106A500 or 106A500X containing chlorine, anhydrous ammonia, sulfur dioxide, methyl chloride, methyl mercaptan, dichlorodifluoromethane, monochlorodifluoromethane, monochlorotetrafluoroethane, vinyl chloride, inhibited, difluoroethane, difluoromonochloroethane, dispersant gas, n.o.s., refrigerant gas, n.o.s., dichlorodifluoromethane and difluoroethane mixture (constant boiling mixture), dichlorodifluoromethane - monofluorotricloromethane mixture, trifluorochloroethylene, dichlorodifluoromethane - dichlorotetrafluoroethane mixture, dichlorodifluoromethane-trichlorotrifluoroethane mixture, dichlorodifluoromethane-monochlorodifluoromethane mixture, or dichlorodifluoromethane-trichloromonofluoromethane - monochlorodifluoromethane mixture; tanks complying with specification 110A500W, containing dichlorodifluoromethane, monochlorodifluoromethane, dichlorodifluoromethane - monofluorotrichloromethane mixture, dichlorodifluoromethane-dichlorotetrafluoroethane mixture, dichlorodifluoromethane-trichlorotrifluoroethane mixture, dichlorodifluoromethane-monochlorodifluoromethane mixture, dichlorodifluoromethane-trichloromonofluoromethane - monochlorodifluoromethane mixture, dispersant gas, n.o.s., or refrigerant gas, n.o.s.; tanks complying with specification 106A800 or 106A800X, containing hydrogen sulfide; or tanks complying with specification 106A800NCI, containing nitrosyl chloride, may be transported on trucks or semi-trailers only, when securely chocked or clamped thereon to prevent shifting, and provided adequate facilities are present for handling tanks where transfer in transit is necessary. See § 74.560 (b) (1).

(d) Engine to be stopped in tank motor vehicles, except for transfer pump. No flammable compressed gas shall be loaded into or on unloaded from any tank motor vehicle with the engine running unless the engine is used for the operation of the transfer pump of the vehicle. Unless the delivery hose is equipped with a shut-off valve at its discharge end, the engine of the motor vehicle shall be stopped at the finish of such loading or unloading operation while the filling or discharge connections are disconnected.

(e) Chlorine cargo tanks shall be shipped only when equipped (1) with a gas mask of a type approved by the U. S. Bureau of Mines for chlorine service; (2) with an emergency kit for controlling leaks in fittings on the dome cover plate.

(f) No chlorine tank motor vehicle used for transportation of chlorine shall be moved, coupled or uncoupled, when any loading or unloading connections are attached to the vehicle, nor shall any semi-trailer or trailer be left without the power unit unless such semi-trailer or trailer be chocked or equivalent means be provided to prevent motion.

§ 77.841 **Poisons.** (See also § 77.834 (a) to (k) of this part.) (a) Arsenical compounds in bulk. Care shall be exercised in the loading and unloading of "arsenical dust," arsenic trioxide," and "sodium arsenate," allowable to be loaded into sift-proof, steel hopper-type or dump-type motor-vehicle bodies equipped with water-proof, dust-proof covers well secured in place on all openings, to accomplish such loading with the minimum spread of such compounds into the atmosphere by all means that are practicable; and no such loading or unloading shall be done near or adjacent to any place where there are or are likely to be, during the loading or unloading process, assemblages of persons other than those engaged in the loading or unloading process, or upon any public highway or in any public place.

(b) No class A or class C poisons in cargo tanks. No dangerous poison, class A, or any tear gas or irritating substance, class C, may be loaded into or transported in any cargo tank.

(c) Class A or class C poisons. It shall not be permissible to transport class A or class C poisons if there be any interconnecting means of any character between the containers.

NOTE 1. Tanks complying with specification 106A500 or 106A500X, containing nitrogen dioxide, liquid (nitrogen peroxide, tetroxide) or phosgene, may be transported on trucks or semi-trailers only, when securely

(continued on p. 1444)

SUBPART C—LOADING AND STORAGE CHART OF EXPLOSIVES AND OTHER DANGEROUS ARTICLES

§ 77.848 Loading and storage chart of explosives and other dangerous articles. (a) Explosives or other dangerous articles must not be loaded, transported or stored together, except as provided in the Loading and Storage Chart of Explosives and Other Dangerous Articles shown in this section.

The following table shows the explosives and other dangerous articles which must not be loaded or stored together.

The letter X at an intersection of horizontal and vertical columns shows that these articles must not be loaded or stored together, for example: detonating fuzes class A, with or without radioactive components g horizontal column must not be loaded or stored with high explosives or propellant explosives, class A b vertical column.

		Low explosives or black powder	High explosives or propellant explosives, class A	Initiating or priming explosives, wet: Diazodinitrophenol, fulminate of mercury, guanyl nitrosamino guanylidene hydrazine, lead azide, lead styphnate, nitro mannite, nitrosoguanidine, pentaerythrite tetranitrate, tetrazene	Blasting caps, with or without safety fuse (including electric blasting caps), detonating primers	Ammunition for cannon with explosive projectiles, gas projectiles, smoke projectiles, incendiary projectiles, illuminating projectiles or shell, ammunition for small arms with explosive bullets, or ammunition for small arms with explosive projectiles, or rocket ammunition with explosive projectiles, gas projectiles, smoke projectiles, incendiary projectiles, illuminating projectiles; and boosters (explosive), bursters (explosive), or supplementary charges (explosive) without detonators, [c], [d]	Explosive projectiles, bombs, torpedoes, or mines, rifle or hand grenades (explosive), jet thrust units (jato), explosive, class A, or igniters, jet thrust (jato), explosive, class A [e]	Detonating fuzes, class A, with or without radioactive components	Ammunition for cannon with empty, inert-loaded or solid projectiles, or without projectiles, or rocket ammunition with empty projectiles, inert-loaded or solid projectiles or without projectiles	Propellant explosives, class B, jet thrust units (jato), class B, igniters, jet thrust (jato), class B, or starter cartridges, jet engine, class B	Fireworks, special or railway torpedoes	Small arms ammunition	Primers for cannon or small arms, empty cartridge bags—black powder igniters, empty cartridge cases, primed, empty grenades, primed, combination primers or percussion caps, toy caps, explosive cable cutters, explosive rivets	Percussion fuzes, tracer fuzes or tracers	Time, combination or detonating fuzes, class C	Cordeau detonant fuse, safety squibs, fuse lighters, fuse igniters, delay electric igniters, electric squibs, instantaneous fuse or igniter cord	Fireworks, common, highway fusees or railway fusees	Flammable liquids or compressed flammable gases, red label	Flammable solids or oxidizing materials, yellow label	Acids or corrosive liquids, white label	Compressed nonflammable gases, green label	Poisonous gases or liquids, in cylinders, projectiles or bombs, poison gas label	Radioactive materials (class D poisons)
		a	b	c	d	e	f	g	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLASS A EXPLOSIVES																							
Low explosives or black powder	a	....	....	X	....	....	....	....	....	....	X	....	....	....	....	....	X	X	X	X	X	X	X
High explosives or propellant explosives, class A	b	....	....	X	[a] X	....	....	X	....	....	X	....	....	....	....	....	X	X	[e] X	X	X	X	X
Initiating or priming explosives, wet: Diazodinitrophenol, fulminate of mercury, guanyl nitrosamino guanylidene hydrazine, lead azide, lead styphnate, nitro mannite, nitrosoguanidine, pentaerythrite tetranitrate, tetrazene	c	X	X	....	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Blasting caps, with or without safety fuse (including electric blasting caps), detonating primers	d	....	[a] X	X	....	X	X	....	....	....	[a] X	....	....	....	....	....	[a] X	[a] X	[a] [e] X	[a] X	[a] X	X	X
Ammunition for cannon with explosive projectiles, gas projectiles, smoke projectiles, incendiary projectiles, illuminating projectiles or shell, ammunition for small arms with explosive bullets, or ammunition for small arms with explosive projectiles, or rocket ammunition with explosive projectiles, gas projectiles, smoke projectiles, incendiary projectiles, illuminating projectiles; and boosters (explosive), bursters (explosive), or supplementary charges (explosive) without detonators, [c], [d]	e	....	....	X	X	....	....	X	....	....	X	....	....	....	....	....	X	X	X	X	X	X	X
Explosive projectiles, bombs, torpedoes, or mines, rifle or hand grenades (explosive), jet thrust units (jato), explosive, class A, or igniters, jet thrust (jato), explosive, class A [e]	f	....	....	X	X	....	....	X	....	....	X	....	....	....	....	....	X	X	X	X	X	X	X
Detonating fuzes, class A, with or without radioactive components	g	....	X	X	....	X	X	....	....	....	X	....	....	....	....	....	X	X	X	X	X	X	X

CLASS B EXPLOSIVES																							
Ammunition for cannon with empty, inert-loaded or solid projectiles, or without projectiles, or rocket ammunition with empty projectiles, inert-loaded or solid projectiles or without projectiles	1			X																[b] X		X	
Propellant explosives, class B, jet thrust units (jato), class B, igniters, jet thrust (jato), class B, or starter cartridges, jet engine, class B	2			X																[b] X		X	
Fireworks, special, or railway torpedoes	3	X	X	X	[a] X	X	X	X														X	
CLASS C EXPLOSIVES																							
Small arms ammunition	4			X																			
Primers for cannon or small arms, empty cartridge bags—black powder igniters, empty cartridge cases, primed, empty grenades, primed, combination primers or percussion caps, toy caps, explosive cable cutters, explosive rivets	5			X																			
Percussion fuzes, tracer fuzes or tracers	6			X																			
Time, combination or detonating fuzes, class C	7			X																			
Cordeau detonant fuse, safety squibs, fuse lighters, fuse igniters, delay electric igniters, electric squibs, instantaneous fuse or igniter cord	8			X																			
Fireworks, common, highway fusees or railway fusees	9	X	X	X	[a] X	X	X	X														X	
OTHER DANGEROUS ARTICLES																							
Flammable liquids or compressed flammable gases, red label	10	X	X	X	[a] X	X	X	X														X	
Flammable solids or oxidizing materials, yellow label	11	X	[c] X	X	[a] [c] X	X	X	X												[b] X		X	
Acids or corrosive liquids, white label	12	X	X	X	[a] X	X	X	X	[b] X	[b] X									[b] X			X	
Compressed nonflammable gases, green label	13	X	X	X	[a] X	X	X	X															
Poisonous gases or liquids, in cylinders, projectiles or bombs, poison gas label	14	X	X	X	X	X	X	X	X	X	X						X	X	X	X			
Radioactive materials (class D poisons)	15	X	X	X	X	X	X	X															

[a] Blasting caps or electric blasting caps in quantities not exceeding 1,000 caps may also be loaded and transported with articles named in vertical and horizontal columns 3, 9, 10, 11, 12 and 13. Loading and transportation of blasting caps or electric blasting caps except as prescribed in § 77.835, in any quantity, with articles named in vertical or horizontal columns b, c, e or f is prohibited.

[b] Acid or other corrosive liquids, white label, must not be loaded above or adjacent to flammable solids or oxidizing materials, yellow label, ammunition for cannon with or without projectiles, or propellant explosive, except that shippers loading truckload shipments of white label and yellow label packages may load such articles together when it is known that the mixture of contents would not cause a dangerous evolution of heat or gas.

[c] Explosives, class A, and explosives, class B, must not be loaded or stored with chemical ammunition containing incendiary charges or white phosphorus either with or without bursting charges. Chemical ammunition of the same classification containing incendiary charges or white phosphorus may be loaded and stored together.

[d] Bursters (explosive), boosters (explosive), or supplementary charges (explosive) without detonators when shipped by, to or for the Departments of the Army Navy, and Air Force of the United States Government may be loaded with any of the articles named except those in columns c, d, 3, 9, 10, 11, 12, 13, 14, and 15.

[e] Does not include nitro carbo nitrate which may be loaded, transported or stored with high explosives or with blasting caps or electric blasting caps, and detonating primers.

NOTE 1: Charged electric storage batteries must not be loaded in the same vehicle with explosives, class A.

NOTE 2: Cyanides or cyanide mixtures must not be loaded or stored with acids or corrosive liquids.

NOTE 3: Gas identification sets may be loaded and transported with all articles named except those in column c.

NOTE 4: Nitric acid, when loaded in the same motor vehicle with other acids or other corrosive liquids in carboys, must be separated from the other carboys. A 2 by 6 inch plank, set on edge, should be nailed across the motor vehicle floor at least 12 inches from the nitric acid carboys, and the space between the plank and the carboys of nitric acid should be filled with sand, sifted ashes, or other incombustible absorbent material.

chocked or clamped thereon to prevent shifting, and provided adequate facilities are present for handling tanks where transfer in transit is necessary.

(d) Radioactive material. A container of radioactive material bearing radioactive material, red label, must not be placed in vehicles, terminals, or other places closer than 3 feet to an area which may be continuously occupied by passengers, employees, or shipments of animals. When more than one such container is present, the distance from occupied areas must be computed from the table in subparagraph (1) of this paragraph by adding the number of units shown in labels on the containers.

(1) A container of radioactive material, red label, must not be placed closer than 15 feet to any package containing undeveloped film. If more than one such container is present the distance must be computed from the table in this subparagraph by adding the number of units shown on the labels on the packages.

TABLE

Total number of units	Minimum distance in feet to nearest undeveloped film	Distance in feet to area that may be continuously occupied by passengers or employes for periods:	
		Up to 8 hours	Exceeding 8 hours
1 to 10	15	3	5
11 to 20	20	4	7
21 to 30	25	5	9
31 to 40	30	6	10

NOTE 1. The distance in the table must be measured from the nearest point of the radioactive container or containers.

NOTE 2. 1 unit equals 1 milliroentgen per hour at 1 meter for hard gamma radiation or the amount of radiation which has the same effect on films as 1 mrhm. of hard gamma rays or radium filtered by ½ inch of lead.

(2) Not more than 40 units of radioactive material, red label, shall be transported in any vehicle or stored in any location at one time. Packages must be so blocked or braced in vehicles as to prevent any shift of lading under conditions normally incident to transportation.

(3) All containers of radioactive material, red label, must be carried by the handles when handles are provided.

(4) Radioactive materials (class D poisons) must not be loaded in the same vehicle with class A explosives.

(5) If for any reason, a package containing radioactive materials, red label, would otherwise remain in the same building for a period longer than 24 hours, it must be moved to a different location after each 24 hours.

SUBPART D—VEHICLES AND SHIPMENT IN TRANSIT; ACCIDENTS

NOTE: See § 77.807 of this part for emergency shipments

§ 77.853 Transportation and delivery of shipments— (a) No unnecessary delay in movement of shipments. All shipments of explosives or other dangerous articles shall be transported without unnecessary delay, from and including the time of commencement of the loading of the cargo until its final discharge at destination.

(b) Delivery at destination. Shipments of explosives and other dangerous articles which are refused by the consignees, or which can not be delivered within 48 hours after arrival at destination, must be promptly disposed of (1) by return to the shipper, if in proper shipping condition, or (2) by storage, provided a suitable storage place for such articles is available, or (3) by sale, or (4) when necessary to safety, by destruction: Provided, That charged electric batteries may be held for 30 days after arrival at destination, pending delivery or disposition.

(c) Delivery to authorized person, or magazine. Every shipment of dangerous explosives by motor vehicle shall be delivered only to someone authorized to receive it, except such explosives shipments as are placed in magazines which are immediately thereafter locked.

§ 77.854 Disabled vehicles and broken or leaking packages; repairs. (See also Forbidden articles, § 77.821) (a) Care of lading, explosives or other dangerous articles. Whenever for any cause other than necessary traffic stops any motor vehicle transporting any explosive or other dangerous article is stopped upon the traveled portion of any highway or shoulder thereof, special care shall be taken to guard the vehicle and its load or to take such steps as may be necessary to provide against hazard. Special effort shall be made to remove the motor vehicle to a place where the hazards of the materials being transported may be provided against. See §§ 192.22 to 192.26[1] inclusive, for signals required to be displayed on the highway.

(b) Disposition of containers found broken or leaking in transit. When leaks occur in packages or containers during the course of transportation, subsequent to initial loading, disposition of such package or container shall be made by the safest practical means afforded under paragraphs (c), (d), and (e) of this section.

(c) Repairing packages. Packages may be repaired when safe and practicable, such repairing to be in accordance with the best and safest practice known and available.

(d) Transportation of repaired packages. Any package repaired in accordance with the requirements of paragraph (c) of this section, except as provided in §§ 77.855 (c), 77.856 (c) and 77.858 (b) of this part, may be transported to the nearest place at which it may safely be disposed of only in compliance with the following requirements:

(1) The package must be safe for transportation.

(2) The repair of the package must be adequate to prevent contamination of or hazardous admixture with other lading transported on the same motor vehicle therewith.

(3) If the carrier is not himself the shipper, the consignee's name and address must be plainly marked on the repaired package.

(e) Disposition of unsafe broken packages. In the event any leaking package or container cannot be safely and adequately repaired for transportation or transported, it shall be stored pending proper disposition in the safest and most expeditious manner possible.

(f) Stopped vehicles; other dangerous articles. Whenever any motor vehicle transporting flammable liquids, flammable solids, oxidizing materials, corrosive liquids, compressed gases, or poisons, is stopped for any cause other than necessary traffic stops upon the travelled portion of any highway, or a shoulder next thereto, the following requirements shall be complied with during the period of such stop:

(1) For motor vehicles other than cargo tank motor vehicles used for the transportation of flammable liquids or flammable compressed gases and not transporting explosives, class A or class B, flares (pot torches), fusees, red electric lanterns, red emergency reflectors, and red flags shall be displayed as required under §§ 192.22, 192.23, 192.24 and 192.26.[1]

(2) For cargo tank motor vehicles used for the transportation of flammable liquids or flammable compressed gases, whether loaded or empty, and vehicles transporting explosives class A or class B, red electric lanterns, red emergency reflectors and red flags shall be displayed as required in §§ 192.25 and 192.26.[1]

Sections referred to will be found in I.C.C. Motor Carrier Safety Regulations.

(g) Repairs to disabled vehicles. No repairs shall be made on any motor vehicle containing explosives or other dangerous articles except in case such repairs may be made without hazard; nor shall any such loaded motor vehicle be repaired in a closed garage.

§ 77.855 Accidents; explosives—(a) Vehicle disabled; warning of nearby persons; removal of explosives. In the event of an accident involving any motor vehicle transporting any explosives, every available means shall be employed to prevent individuals, other than those employed in the protection of persons or property or in the removal of hazards or wreckage, from congregating in the vicinity; such means shall also be employed to prevent smoking, to keep flame away, and to safeguard against the aggravation of the hazard present, and to warn other users of the highway. In the event that any motor vehicle laden with or carrying dangerous explosives is entangled with another or with any other object or structure, following an accident, no attempt shall be made to disentangle either vehicle, or the laden vehicle from the object or structure, until the lading, together with any fragments thereof, be removed to a place at least 200 feet from the vehicle (and preferably 200 feet from any habitation). In the event of fire, involving a motor vehicle laden with any explosive, every practical effort shall be made to give warning of danger of explosion to habitants in the vicinity and to other users of the highway.

(b) Disposition of spilled or leaking explosives. In the event of any accident involving any motor vehicle transporting any explosive in which packages are broken, all unbroken packages and as much of any broken packages as possible shall be carefully gathered and removed to a place of safety, in order to prevent fire or explosion. In clearing any wreck in which a motor vehicle containing any explosive is involved, care shall be exercised not to produce sparks with tools or by other means in moving of or working about the wreckage, so as to avoid as far as possible fires or explosions.

(c) Explosives packages in transit capable of repair. Any package of explosives found injured or broken in transit may be repaired or recoopered when this is evidently practicable and not dangerous. When a box that contains any explosive is so damaged that it cannot be repaired it should be reinforced by stout wrapping paper and twine, placed in another strong box, and surrounded by dry, fine sawdust, or dry and clean cotton waste, or elastic wads made from dry newspapers. The box cover should then be securely attached. A ruptured can or keg should be inclosed in a grain bag of good quality, and boxed. Injured packages thus protected, and properly marked with name of contents and consignee's name and address, may be carried to destination: Provided, however, That the motor carrier, if himself the shipper, need not mark his own name and address on the package.

(d) Liquid nitroglycerin, desensitized liquid nitroglycerin or diethylene glycol dinitrate. When any liquid nitro glycerin, desensitized liquid nitroglycerin or diethylene glycol dinitrate has been spilled on any portion of any motor vehicle it shall be washed with a suitable neutralizing agent until all of any such spillage shall have become completely neutralized.

NOTE 1: Liquid nitroglycerin, desensitized liquid nitroglycerin or diethylene glycol dinitrate may be destroyed by use of a solution composed of:

60 percent commercial sodium sulfide	1 ounce
Denatured alcohol	7½ fluid ounces
Acetone	2 fluid ounces
Water	3 fluid ounces

(e) Explosives other than liquid nitroglycerin, desensitized liquid nitroglycerin or diethylene glycol dinitrate. When particles of any explosive composition other than liquid nitroglycerin, desensitized liquid nitroglycerin or diethylene glycol dinitrate have escaped from a damaged container to the floor of the body of the carrier's motor vehicle, the floor shall be thoroughly swept and any absorbed portion removed.

(f) Unrepairable explosives packages. When any package of explosives in transit is found to be leaking or damaged and cannot be recoopered, it may not be transported beyond the minimum distance necessary to reach a place where the explosive may be disposed of with safety, except as provided in § 77.854 (e) and paragraph (c) of this section.

§ **77.856 Accidents; flammable liquids—(a)** Accident to vehicle; warnings; no sparks or flame. In the event of an accident involving any motor vehicle transporting any flammable liquid every available means shall be employed to prevent individuals, other than those employed in the protection of persons or property or in the removal of hazards or wreckage, from congregating in the vicinity; such means shall also be employed to prevent smoking, to keep fires or flame away, to safeguard against the hazard present, and to warn other users of the highway. (See also § 77.814 of this part.)

(b) Prevent leakage from spreading. Whenever any flammable liquid is escaping from a container, all practical means shall be taken to prevent such liquid from spreading over a wide area, from flowing into sewers and streams, and from becoming ignited.

(c) Disposition of contents of cargo tank when unsafe to continue. In the event of a leak in a cargo tank of such a character as to make further transportation unsafe, the leaking vehicle should be removed from the traveled portion of the highway; and every available means employed for the safe disposal of the leaking liquid by preventing, so far as practicable, its spread over a wide area, such as by digging trenches to drain to a hole or depressions in the ground, diverting the liquid away from streams or sewers if possible, or catching the liquid in containers if practicable. Smoking and the lighting of cigarettes, cigars, or pipes in the vicinity is prohibited, and fires or flames in the vicinity of the leaking cargo tank must be extinguished.

(d) Transfer of flammable liquids en route. No flammable liquids shall be transferred from one container to another, or from one motor vehicle to another vehicle, or from another vehicle to a motor vehicle, on any public highway, street, or road, except in case of emergency. In such cases red electric lanterns, red emergency reflectors, or red flags shall be set out in the manner prescribed for disabled or stopped motor vehicles in Motor Carrier Safety Regulations (Part 193). In any event, all practicable means, in addition to those hereinbefore prescribed, shall be taken to protect and warn other users of the highway against the hazard involved in any such transfer, or against the hazard occasioned by the emergency making such transfer necessary. Nothing contained in this rule shall be so construed as to prohibit the fueling of machinery or vehicles used in road construction and maintenance.

(e) Transportation of leaking cargo tanks. A leaking cargo tank may only be transported the minimum distance necessary to reach a place where the contents of the tank or compartment may be disposed of with safety. Every available means must be utilized to prevent the leakage or spillage of the liquid upon the highway.

§ **77.857 Accidents, flammable solids and oxidizing materials—** (a) Dangerous articles spilled; warning of nearby persons. In the event of any accident involving any motor vehicle in which any flammable solid or oxidizing material may have become spilled, every practicable and available means shall be taken to warn all approaching persons of the hazard of fire.

(b) Prevent spread of fire where possible. Care shall be exercised in the event of damage to packages of flammable solids or oxidizing materials which either have been or may be on fire, to limit the spread of the fire.

(c) Disposition of spilled or leaking materials. In the event of any accident involving any motor vehicle transporting any flammable solid or oxidizing material in which packages are broken, as much as possible of any broken packages shall be carefully gathered and removed to a place of safety, and if the removal of unbroken packages from the motor vehicle would decrease the hazard of fire or other hazard, they shall be removed. The handling of any such materials not contained in packages shall be such as to promote the greatest safety to other users of the highway.

(d) Reloading of damaged packages of matches; repairs. In the event of damage to matches or packages of matches by fire or by water in extinguishing a fire in transit, they shall be reloaded in accordance with the applicable requirements for the packing and loading of matches. Great care shall be taken, however, first to examine and repair any damage to outside containers before reloading, and all loose matches shall be destroyed. Smoking boxes of matches shall not be opened in the vicinity of the remainder of the lading. Such boxes shall be destroyed at a safe distance from the motor vehicle, preferably by burning, and shall not be left, either smoking or burning.

(e) Calcium hypochlorite compounds, dry, involved in fires. Calcium hypochlorite compounds, dry, packed in metal drums when involved in motor vehicles where fire has occurred from any cause must be held at least five days before forwarding. Drums showing evidence of spontaneous heating or stress from internal pressure must not be reshipped.

§ **77.858 Accidents; corrosive liquids—(a)** Accident to vehicle; other lading damaged; vehicle washed. In the event of any accident involving any motor vehicle transporting corrosive liquids in which has been involved the breakage, spillage, or leakage of containers of such liquids, care shall be exercised in the handling of any other lading which may have become damaged thereby so as to minimize the hazard in handling such damaged lading during the unloading process; and the interior of any other parts of the motor vehicle upon which the corrosive liquids may have become spilled shall be thoroughly washed with water as soon after the unloading process as feasible and prior, in any event, to the subsequent reloading of the motor vehicle. (See also § 77.814 of this part.)

(b) Leaking cargo tanks. In the event of leakage of liquid from any cargo tank or any compartment thereof used for the transportation of corrosive liquids, which develops or is discovered subsequent to the commencement of transportation, any one of the following means, or any means in addition to those herein prescribed, equally or more effective, shall be employed to minimize further hazard:

(1) Further to transport the cargo tank only the minimum distance to reach a place where the contents of the tank or compartment which is leaking may be disposed of with safety, meanwhile employing every available means to prevent spillage or leaking of any liquid on the highway.

(2) In the event the leak is of such a character as to make further transportation of the cargo tank unsafe, to draw off the traveled portion of the highway, and to employ every available means for the safe disposal of the leaking liquid by preventing so far as practicable its spread over a wide area, as by absorbing by means of the use of noncombustible absorbent material, such as fine ashes, sand, earth, etc., or by other practicable means; by digging trenches to drain to a hole or depression in the ground; by diverting the liquid away from streams or sewers if possible; or by catching the liquid in containers if practicable. So far as practicable, every available means shall be employed to prevent the congregation of spectators and to prevent them from coming in contact with the liquid or its fumes. All available means shall be taken to prevent injury or damage to other

users of the highway, or to livestock or farm animals, which might be occasioned by the unloading of the corrosive liquid.

§ 77.859 **Accidents; compressed gases.**—(a) Accident to vehicle; warnings; keep fire away. In the event of an accident involving any motor vehicle transporting any compressed gas, the release of which would constitute a hazard to other users of the highway, due care shall be taken that only persons employed in the removal of hazards or wreckage shall be allowed in proximity to the motor vehicle, and the shipper should be notified. In such cases, every practcable and available means shall be taken to warn all approaching persons of the danger involved and to caution them against the use of matches or flame-producing devices, if the gas is flammable.

(b) Transfer of flammable gas en route; no flame or sparks. No flammable compressed gas shall be transferred from one container to another, or from one tank motor vehicle to another tank vehicle, or from another tank vehicle to a tank motor vehicle, on any public highway, street, or road, except in case of emergency. In such cases every precaution shall be taken to prevent the escape of gas. Red electric lanterns, red emergency reflectors, or red flags shall be set out in the manner prescribed in Motor Carrier Safety Regulations (Part 193). All cargo tanks involved in such transfer shall be grounded. The transfer shall be made only during daylight, unless the emergency occurs at night or extends into hours of darkness and the hazard would be increased by waiting until daylight. In any such event, all practicable means, in addition to those hereinbefore prescribed, shall be taken to protect and warn other users of the highway against the hazard involved in any such transfer, or against the hazard occasioned by the emergency making such transfer necessary. Every precaution shall be taken to prevent the ignition of any flammable compressed gas from any source; and when it is possible to prevent the congregation of persons not directly concerned with the emergency, this shall be done. Every practicable precaution shall be taken to keep flames or fire away from the scene of the emergency and to prevent smoking or the lighting of pipes, cigars, or cigarettes. Similarly, special care shall be exercised in the operation of any engine, whether of the motor vehicles involved or any other, and where the operation of any such engine would be likely to produce ignition of the flammable compressed gas, the transfer shall be accomplished by other means, if possible. Nothing contained in this section shall be so construed as to prohibit the fueling of machinery or vehicles used in road construction and maintenance.

§ 77.860 **Accidents; poisons.**—(a) Accident to vehicle; warnings; no sparks or flame. In the event of an accident involving any motor vehicle transporting any poison which is flammable, noxious, or toxic, every available means shall be employed in the protection of persons or property or in the removal of hazards or wreckage, from congregating in the vicinity; such means shall also be employed to prevent smoking, to keep flame away, to safeguard against the aggravation of the hazard present, and to warn other users of the highway. Care shall also be taken to prevent any poison, whether flammable or nonflammable, from contaminating streams or flowing or being spilled into sewers, and poison in powdered form from being scattered by wind. (See also § 77.814 of this part.)

(b) Leaking cargo tanks. In the event of leakage of liquid from any cargo tank or any compartment thereof used for the transportation of any poison which is also flammable, or which would come also within the defintion of a flammable liquid, or of any gas or combination of gas and liquid, or any poison which would come within the definition of a compressed gas, the requirements shall be the same as those set forth for flammable liquids and compressed gases. In addition, all possible care shall be taken to warn bystanders or other users of the highway against the hazard of inhaling vapors or coming in contact with the poison.

(c) Radioactive materials; poison D. In case of accident to vehicle resulting in breakage of, or unusual delay to any shipment of radioactive material the package or material should be segregated as far as possible from human contact. The shipper and the Bureau of Explosives should be immediately notified. In case of breakage of a package containing radioactive material and when it appears likely that the inside container may have been damaged, great care must be exercised to prevent contact with or inhalation of radioactive material by any person.

(d) Cleaning vehicles. Any motor vehicle which, after use for the transportation of radioactive materials in truckload lots, is contaminated with such materials to the extent that a survey of the interior surface shows that the beta-gamma radiation is greater than 10 milliroentgens physical equivalent in 24 hours or that the average alpha contamination is greater than 500 disintegrations per minute per 100 square centimeters shall be thoroughly cleaned in such a manner that a resurvey of the interior surface shows the contamination to be below these levels. A certificate to that effect must be furnished the carrier or to the driver of the motor vehicle. Motor vehicles which are used solely for the transportation of radioactive materials are exempt from the provisions of this section.

SUBPART E—REGULATIONS APPLYING TO EXPLOSIVES OR OTHER DANGEROUS ARTICLES ON MOTOR VEHICLES CARRYING PASSENGERS FOR HIRE

§ 77.870 **Regulations for passenger carrying vehicles**—(a) Vehicles transporting passengers and property. In addition to the regulations in Parts 71 to 78 the following requirements shall apply to vehicles transporting passengers and property.

(b) No explosives or other dangerous articles on passenger-carrying vehicles, exceptions. No explosives or other dangerous articles except small-arms ammunition, emergency shipments of drugs, chemicals and hospital supplies, and the accompanying munitions of war of the Departments of the Army, Navy, and Air Force of the United States Government, are authorized by Parts 71-78 to be transported on motor vehicles carrying passengers for hire where other practicable means of transportation is available.

(c) Explosives in passenger-carrying space forbidden. No explosive, except small-arms ammunition, may be carried in the passenger-carrying space of any motor vehicle transporting passengers for hire.

(d) Explosives and other dangerous articles on passenger-carrying vehicles; quantity. Where no other practicable means of transportation is available the following articles in the quantities as shown may be transported in motor vehicles carrying passengers for hire in a space other than that provided for passengers: Not to exceed 100 pounds gross weight of any or all of the kinds of explosives permitted to be transported by rail express or rail baggage services, may be transported on a motor vehicle transporting passengers: Provided, however, That samples of explosives for laboratory examination, not exceeding a net weight of one-half pound each, and not exceeding 20 samples or not to exceed a total of 100 blasting caps at one time in a single motor vehicle, may be transported in a motor vehicle transporting passengers. (See § 72.5.)

(e) Articles other than explosives on passenger-carrying vehicles. The gross weight of any given class of dangerous article other than explosives shall not exceed 100 pounds, and the aggregate weight of all such other dangerous articles shall not exceed 500 pounds. This provision does not apply to nontoxic, noflammable refrigerants, when such refrigerant is for servicing operations of a motor carrier on whose motor vehicles the refrigerant is used. A cylinder secured against movement while in transit and not exceeding 250 pounds gross weight may be transported.

(f) Poisons on passenger-carrying vehicles. No motor carrier may transport any extremely dangerous poison, class A, any tear gas or irritating substance, class C, any less dangerous poison, class B, which is a liquid, or any paranitraniline, in any amount, in or on any bus while engaged in the transportation of passengers; or any less dangerous poison, class B, which is other than a liquid, in any amount exceeding an aggregate of 100 pounds gross weight in or on any such bus.

(g) Radioactive materials on passenger-carrying vehicles. No motor carrier may transport any radioactive material, poison, class D, requiring red or blue radioactive material label under these regulations in or on any bus while engaged in the transportation of passengers except where no other practicable means of transportation is available. Packages of radioactive materials must be handled and placed in the vehicle in accordance with the requirements of § 77.841 (d) of this part.

Section 12

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Chinese bean oil. See Soybean oil.
Chinese white. See Zinc oxide.
Chinoline. See Quinoline.
Chinone. See Quinone.
Chinosol. See Quinosol.
Chloral hydrocyanide. See Chlorocyanohydrin.
Chloramine. See Chloramine-T.
Chlorauric acid. See Gold chloride.
Chlor(o) azide. See Chlorine azide.
Chlorazine. See Sodium p-toluenesulfonchloramine.
Chlorex. See 2, 2'-Dichloroethyl ether.
Chlorinated acetone. See Chloroacetone.
Chlorinated camphene. See "Toxaphene."
Chlorinated hydrochloric ether. See Ethylidene chloride.
Chlorinated lime. See Calcium chloride hypochlorite.
Chlorine cyanide. See Cyanogen chloride.
Chloroacetic acid. See Monochloroacetic acid.
Chloroaldehyde. See Chloroacetaldehyde.
Chloroazodin. See Azochloramide.
Chlorobenzol. See Chlorobenzene.
Chlorobutadiene. See Chloroprene.
2-Chloro-1, 3-butadiene. See Chloroprene.
1-Chlorobutane. See Butyl chloride.
1-Chloro-2-(beta-chloroethoxy) ethane. See 2, 2'-Dichloroethyl ether.
Chlorodimethylarsine. See Dimethyl chloroarsine.
1-Chloro-2, 4-dinitrobenzene. See Dinitrochlorobenzene.
1-Chloro-2, 3-epoxypropane. See Epichlorohydrin.
Chloroethane. See Ethyl chloride.
Chloroethanoic acid. See Monochloroacetic acid.
Chloroethene. See Vinyl chloride.
β-Chloroethyl alcohol. See Ethylene chlorohydrin.
Chloroethylene. See Vinyl chloride.
Chloroethyne. See Acetylene chloride.
Chloroformamide. See Carbamyl chloride.
Chlorohydric acid. See Hydrochloric acid.
4-Chloro-3-hydroxy toluene. See p-Chloro-m-cresol.
Chloro-isopropyl alcohol. See Propylene chlorohydrin.
6-Chloro-4-isopropyl-1-methyl-3-phenol. See Chlorothymol.
Chloromanganokalite. See Potassium manganous chloride.
o-Chloromercuriphenol. See o-Hydroxyphenylmercuric chloride.
Chloromethane. See Methyl chloride.
2-Chloro-1-methylbenzene. See o-Chlorotoluene.
3-Chloro-1-methylbenzene. See m-Chlorotoluene.
4-Chloro-1-methylbenzene. See p-Chlorotoluene.
1-Chloro-3-nitrobenzene. See m-Chloronitrobenzene.
4-Chloro-1-nitrobenzene. See p-Chloronitrobenzene.
Chlorophenothane. See DDT.
1-(o-Chlorophenoxy)-2-propanol. See Propylene glycol chlorophenyl ether.
1-(p-Chlorophenyl)-5-isopropyl-biguanide hydrochloride. See Chloroguanide.
1-Chloropropane. See n-Propyl chloride.
2-Chloropropane. See Isopropyl chloride.
1-Chloro-2-propanol. See Propylene chlorohydrin.
3-Chloropropene. See Allyl chloride.
6-Chlor-orthoxenol. See 2-Phenyl-6-chlorophenol.
Chlorosulfuric acid. See Sulfuryl chloride.
α-Chlorotoluene. See Benzyl chloride.
Chlorotrifluoromethane. See Monochlorotrifluoromethane.
m-Chlorotrifluoromethylbenzene. See m-Chlorobenzotrifluoride.
p-Chlorotrifluoromethylbenzene. See p-Chlorobenzotrifluoride.
2-Chloro-1, 3, 5-trinitrobenzene. See Picryl chloride.
Chlorovinyldichloroarsine. See Lewisite.
2-Chlorovinyl dichloroarsine. See Dichloro(2-chlorovinyl) arsine.
Chromic anhydride. See Chromic acid.
Chromium-potassium sulfate. See Chrome alum.
Chromium trioxide. See Chromic acid.
Chromyl chloride. See Chromium oxychloride.
Chrysoberyl. See Beryllium aluminate.
Cicuta. See Coniine.
Cicutine. See Coniine.
Cinene. See Dipentene.
Cinnabar. See Mercuric sulfide, red.
Cinnamein. See Benzyl cinnamate.
Cinnamene. See Styrene (monomer).
Clausthalite. See Lead selenide.
Coal naphtha. See Benzene.
Cobalticcyanic acid. See Cyanocobaltic III acid.
Cobaltite. See Cobalt arsenic sulfide.
Cobaltous acetate. See Cobalt acetate.
Cobalt tricarbonyl. See Cobalt carbonyl.
Colophony. See Pine resin; Rosin.
Columbium. See Niobium.
Columbium pentachloride. See Columbium chloride.
Colza oil. See Rapeseed oil.
Conicine. See Coniine.
Copper acetoarsenate. See Paris green.
Copperas. See Ferrous sulfate.
Copper ethylxanthogenate. See Copper xanthate.
Copper mercury iodide. See Mercuric cuprous iodide.
Corrosive sublimate. See Mercuric chloride.
Corundum. See Emery.
Corynine. See Yohimbine.
Cotunnite. See Lead chloride.
4-Cresol. See para-Cresol.
Cresolite. See 2, 4, 6-Trinitro-m-cresol.
Creosote oil. See Creosote, coal tar.
Cresylic acid. See Cresol.
ortho-Cresylic acid. See ortho-Cresol.
Cresylol. See Cresol.
Cristobalite. See Quartz; Silica.
Crocoite. See Lead chromate.
Crotonalic acid. See Tiglic acid.
Crotonic aldehyde. See Crotonaldehyde.
Cryptohalite. See Ammonium fluosilicate.
Crystal ammonium. See Ammonium carbonate.
Crystal carbonate. See Sodium carbonate.
o-Cumenol. See o-Isopropyl phenol.
Cumol. See Cumene; Isopropyl benzene.
Cupric abietinate. See Copper abietinate.
Cupric acetate. See Copper acetate.
Cupric arsenite. See Copper arsenite.
Cupric boride. See Copper boride.
Cupric carbonate. See Copper carbonate.
Cupric chloride. See Copper chloride.
Cupric cyanide. See Copper cyanide.
Cupric fluoride. See Copper fluoride.
Cupric hydroxide. See Copper hydroxide.
Cupric nitrate. See Copper nitrate.
Cupric oleate. See Copper oleate.
Cupric oxalate. See Copper oxalate.
Cupric oxide. See Copper oxide.
Cupric oxychloride. See Copper oxychloride.
Cupric phosphate, See Copper phosphate.
Cupric phosphide. See Copper phosphide.

Cupric stearate. See Copper stearate.
Cupric sulfate, ammoniated. See Copper sulfate, ammoniated.
Cupric sulfate, basic. See Copper subsulfate.
Cupric sulfide. See Copper sulfide.
Cuprite. See Cuprous oxide.
Cuprous arsenate, basic. See Copper, arsenate, basic.
Cuprous silicofluoride. See Cuprous fluosilicate.
Cuprous thiocyanate. See Copper thiocyanate.
Curled mint. See Spearmint oil.
N-Cyanodiethylamine. See Diethyl cyanamide.
Cyanodimethylaminoethoxy phosphine oxide. See Tabun.
Cyanogenamide. See Cyanamide.
Cyanogen thiocyanate. See Cyanogen sulfide.
Cyanoguanidine. See Dicyandiamide.
Cyclobutylene. See Cyclobutene.
Cyclohexylbenzene. See Phenylcyclohexane.
Cyclohexylmethane. See Methylcyclohexane.
Cyclonite. See Cyclotrimethylene trinitramine; Trimethylene trinitramine.
Cyclotetramethylene oxide. See Tetrahydrofuran.
Cypronic ether. See Cyclopropyl methyl ether.
2, 4-D. See Butyl 2, 4-Dichlorophenoxyacetate; 2, 4-Dichlorophenoxyacetic acid.
DBMC. See Di-tert-Butyl-m-cresol.
DBPC. See Di-tert-Butyl-p-cresol.
DMDT. See Methoxychlor; 1-Trichloro-2, 2-bis (p-methoxyphenyl) ethane.
DVPy. See Divinyl pyrethrin I.
Daturine. See Atropine; Hyoscyamine.
Deadly nightshade. See Belladonna.
Decaboron tetradecahydride. See Decaborane.
Decahydronaphthalene. See "Decalin."
1-Decanol. See n-Decyl alcohol.
n-Decylene. See 1-Decene.
Decyl hydride. See Decane.
de Haens salt. See Antimony salt.
Denatured spirits. See Alcohol, denatured.
Dermatol. See Bismuth gallate, basic.
Dextrose nitrate. See Nitrolevulose.
Diacetic ether. See Ethyl acetoacetate.
1, 2-Diacetylethane. See Acetonyl acetone.
Diacetyl peroxide solution. See Acetyl peroxide 25% solution.
Diallyl disulfide. See Allyl sulfide.
Diallyl ether. See Allyl ether.
Diallyl trisulfide. See Allyl trisulfide.
Diamine. See Hydrazine.
Diaminobenzene. See p-Phenylene diamine.
m-Diaminobenzene. See m-Phenylenediamine.
o-Diaminobenzene. See o-Phenylenediamine.
3-Diamino-4-dihydroxy-1-arsenobenzene hydrochloride. See Arsphenamine.
p-Diaminodiphenyl. See Benzidine.
1, 2-Diaminoethane. See Ethylenediamine.
Diaminophenol hydrochloride. See Amidol.
2, 5-Diaminotoluene. See 2, 5-Toluene diamine.
Diamorphine. See Diacetyl morphine.
Di-n-amylamine. See Diamylamine.
Diamyl ether. See Amyl ether.
Diamyl sulfide. See Amyl sulfide.
Diazoaminobenzene. See alpha-Diazoamidobenzol.
Diazobenzeneimide. See Diazobenzolimide; Phenyl azoimide.
Diazobenzene sulfate. See Diazobenzol sulfate.
Diazotizing salts. See Sodium nitrite.
Dibenzofuran. See Diphenylene oxide.
Dibenzopyrazine. See Phenazine.
Dibenzopyrrole. See Carbazole.
Dibenzothioxin. See Phenothioxin.
Dibenzoxyhydroquinone. See Dibenzyl ether of hydroquinone.
Dibenzoyl. See Benzil.
Diboranide. See Potassium diborane.
α-β-Dibromoethyl benzene. See Styrene dibromide.
Dibromethyne. See Dibromoacetylene.
1, 2-Dibromoethane. See Ethylene dibromide.
Dibutyl-1, 2-benzene dicarboxylate. See Dibutyl o-phthalate.
Dibutyl-1, 2-cyclohexane dicarboxylic acid. See Dibutyl hexahydrophthalate.
Dibutyldiacetoxystannane. See Dibutyl tin diacetate.
Dibutyldichlorostannane. See Dibutyl tin dichloride.
Dibutyl-d-2, 3-dihydroxybutane dioate. See Dibutyl tartrate.
n-Dibutyl ether. See Butyl ether.
Dibutylmalyldioxystannane. See Dibutyl tin maleate.
Dibutyloxostannane. See Dibutyl tin oxide.
Dibutyl sulfide. See Butyl sulfide.
Dicacodyl. See Cacodyl.
Dicarbitol phthalate. See "Carbitol" phthalate.
2, 2-Dichlorethanal. See Dichloroacetaldehyde.
1, 1-Dichlorethane. See Ethylidene chloride.
Dichlorinated methyl oxide. See Dichloromethyl ether.
1, 3-Dichlorobenzene. See m-Dichlorobenzene.
1, 4-Dichlorobenzene. See p-Dichlorobenzene.
1, 1-Dichloro-2, 2-bis (p-chlorophenyl)-ethane. See DDD.
sym-Dichlorobutane. See 1, 4-Dichlorobutane.
1, 3-Dichloro-2-butene. See Dichlorobutene.
Dichlorodimethyl hydantoin. See 1, 3-Dichloro-5, 5-dimethyl hydantoin.
Dichloro-diphenyl-trichloroethane. See DDT.
Dichloroethane. See Ethylene dichloride.
alpha, beta-Dichloroethyl alcohol. See 1, 2-Dichloroethyl alcohol.
Dichloroethylarsine. See Ethyldichloroarsine.
1, 1-Dichloroethylene. See Vinylidene chloride.
1, 2-Dichloroethylene. See cis-Dichloroethylene.
Di-[2-chloroethyl] formal. See Di-2-chloroethyl formal.
Dichloromethane. See Methylene chloride.
Dichloro-(phenol diphenyl) ether. See Dichloro-(phenolxenyl ether).
Di(4-chlorophenoxy) methane. See Bis (p-chlorophenoxy methane).
1-(2, 4-Dichlorophenoxy)-2-propanol. See Propylene glycol-2, 4-dichlorophenyl ether.
Dichlorophenyl phosphine. See Phosphenyl chloride.
1, 2-Dichloropropene. See 1, 2-Dichloropropylene.
1, 1-Dichloro-2-propanone. See 1, 1-Dichloroacetone.
1, 3-Dichloro-2-propanone. See 1, 3-Dichloroacetone.
alpha, 4-Dichlorotoluene. See p-Chlorobenzyl chloride.
Dicophane. See DDT.
1, 4-Dicyanobutane. See Adiponitrile.
1, 1-Diethoxyethane. See Acetal.
1, 2-Diethoxy ethylene. See Diethyl "Cellosolve."
Diethyl acetaldehyde. See 2-Ethyl butyraldehyde.
Diethyl acetic acid. See 2-Ethyl butyric acid.
Diethyl carbinol. See sec-n-Amyl alcohol.
Diethyldimethylmethane. See 2, 3-Dimethylpentane.
N, N'-Diethyl-N, N'-diphenyl urea. See N, N'-Diethylcarbanilide.
Diethyl disulfide. See 3, 4-Dithiahexane.
Diethylenediamine. See Piperazine.
Diethylene dioxide. See 1, 4-Dioxane.
1, 3-Diethylene disulfide-2, 2-diphenyl. See 1, 3-Dithiane, 2, 2-diphenyl.
Diethylene glycol monobutyl ether. See Butyl "Carbitol."

Diethylene glycol monoethyl ether. See "Carbitol"; Diethyl "Carbitol."
Diethylene glycol monoethyl ether acetate. See "Carbitol" acetate.
Diethylene glycol monomethyl ether. See Methyl "Carbitol."
Diethylene glycol monomethyl ether acetate. See Methyl "Carbitol" acetate.
Diethylene glycol monophenyl ether. See Phenyl "Carbitol."
Diethylene oxide. See 1,4-Dioxane.
Diethylenimide oxide. See Morpholine.
Diethyl ethanedioate. See Ethyl oxalate.
O,O-Diethyl-O,2-(ethylthio) ethyl thiophosphate. See Demeton.
Di-2-ethyl hexyl fumarate. See Dioctyl fumarate.
O,O-Diethyl-O,p-nitrophenyl thiophosphate. See Parathion.
Diethyl sulfide. See Ethyl sulfide.
Diethyl valeramide. See Valyl.
1,1,1-Difluorochloroethane. See Difluoromonochloroethane.
Difluorodibromomethane. See Dibromodifluoromethane.
Difluorodiphenyldichloroethane. See DFDD.
Difluoroethane. See 1,1-Difluoroethane.
1,2-Difluoroethane. See Ethylene difluoride.
Digallane. See Gallium hydride.
Diglycol. See Diethylene glycol.
Diglycol diabietate. See Diethylene glycol diabietate.
Diglycol laurate. See Diethylene glycol laurate.
Diglycol myristate. See Diethylene glycol myristate.
Dihexyl. See Dodecane.
Dihexyl ether. See Hexyl ether.
Dihydropentaborane. See Pentaborane, unstable.
5,6-Dihydro-2,3,6-trimethyl-1,3,5-dithiazine. See Thialdine.
3,4-Dihydroxy anthranol. See Anthrarobin.
1,2-Dihydroxyanthraquinone. See Alizarin.
m-Dihydroxy benzene. See Resorcinol.
o-Dihydroxy benzene. See Pyrocatechol.
2,6-Dihydroxy-4-carboxy pyridine. See Citrazinic acid.
Di(2-hydroxyethyl) amine. See Diethanolamine.
1,6-Dihydroxyhexane. See Hexanediol-1,6.
2,2'-Dihydroxy isopropyl ether. See Dipropylene glycol.
1,8-Dihydroxy-3-methyl-anthraquinone. See Chrysophanic acid.
1,3-Dihydroxynaphthalene. See Naphthoresorcinol.
1,2-Dihydroxypropane. See Propylene glycol.
1,1-Diiodoethane. See Ethylidene diiodide.
Diiodoethyne. See Diiodoacetylene.
Diiodomethane. See Methylene iodide.
Diisobutyl phenol. See Octyl phenol.
Diisopropyl. See 2,3-Dimethylbutane.
Diisopropyl alcohol. See Isopropyl ether.
1,4-Dimethoxybenzene. See Hydroquinone dimethyl ether.
Dimethoxybenzidine. See Dianisidine.
1,2-Dimethoxy ethane. See Ethylene glycol dimethyl ether.
Dimethoxy tetraethylene glycol. See Dimethoxytetraglycol; Tetraethylene glycol dimethyl ether.
Dimethyl. See Ethane.
Dimethylaminoantipyrine. See Aminopyrine.
Dimethyl analog of parathion. See O,O-Dimethyl-O, p-nitrophenyl thiophosphate.
Dimethylarsenic acid. See Cacodylic acid.
alpha-Dimethyl benzyl hydroperoxide. See Cumene hydroperoxide.
N,N-Dimethyl carbamyl chloride. See Dimethyl carbamyl chloride.
Dimethyl carbinol. See Isopropyl alcohol.
3-Dimethylcarbinol propylamine. See 3-Isopropoxypropylamine.
Dimethyl "Cellosolve" phthalate. See Dimethylglycol phthalate.
Dimethyl-1-cyclohexene-1,2-dicarboxylic acid. See Dimethyl tetrahydrophthalate.
Dimethyl disulfide. See 2,3-Dithiabutane.
O,O-Dimethyl dithiophosphate of diethyl mercaptosuccinate. See Malathion.
Dimethyl ethyl carbinol. See tert-Amyl alcohol, refined.
Dimethylethylene. See cis-Butene-2.
alpha, alpha-Dimethyl ethyl nitrite. See tert-Butyl nitrite.
2,6-Dimethyl-2-5-heptadien-4-one. See Phorone.
2,6-Dimethyl heptanol-4. See Diisobutyl carbinol.
3,5-Dimethyl-1-hexyn-3-ol. See Dimethylhexynol.
Dimethyl ketone. See Acetone.
Dimethylmethane. See Propane.
3,3-Dimethyl-2-methylene norcamphone. See Camphene.
3,6-Dimethyl-4-octyne-3,6-diol. See Dimethyl octynediol.
2,2-Dimethylol propanol-1. See Trimethylolethane.
2,4-Dimethyl-3-pentanol. See Diisopropyl carbinol.
3,5-Dimethyl phenol. See 3,5-Xylenol.
2,2-Dimethyl-1,3-propanediol. See Neopentyl glycol.
Dimethylpropylmethane. See 2-Methylpentane.
p-(alpha-Dimethylpropyl) phenol. See p-tert-Amyl phenol.
2,6-Dimethyl pyridine. See 2,6-Lutidine.
Dimethyl sulfite. See Methyl sulfite.
Dimethyl telluride. See Methyl telluride.
2,4-Dimethyl thiophene. See p-Thioxene.
1,3-Dimethylxanthine. See Theophylline.
3,6-Dimethylxanthine. See Theobromine.
1,3-Di-1-naphthyltriazine. See 1,1'-Diazoamidonaphthalene.
Dinitroaminophenol. See Picramic acid.
2,4-Dinitro-1,3-benzendiol. See 2,4-Dinitroresorcinol.
o-Dinitrobenzol. See 1,2-Dinitrobenzene.
Dinitrochlorobenzol. See 2,1,4-Chlorodinitrobenzene.
2,4-Dinitro-o-cyclohexyl phenol. See 2,4-Dinitro-6-cyclohexyl phenol.
1,5-Dinitronaphthalene. See Dinitronaphthalene.
1,8-Dinitronaphthalene. See Dinitronaphthalene.
2,4-Dinitrophenylamine. See 2,4-Dinitroaniline.
2,4-Dinitrophenylmethyl ether. See 2,4-Dinitro anisole.
Dinitrotoluol. See 2,4-Dinitrotoluene.
Dinol. See Diazodinitrophenol.
Dioctyl phthalate. See Di-2-ethylhexylphthalate.
1,2-Diodoethane. See Ethylene diiodide.
p-Dioxane. See 1,4-Dioxane.
Dioxolone-2. See Ethylene carbonate.
1,2-Diphenyl benzene. See o-Terphenyl.
Diphenyl carbinol. See Benzhydrol.
Diphenyl ether. See Diphenyl oxide.
Diphenylglycolic acid. See Benzilic acid.
Diphenyl ketone. See Benzophenone.
Diphenylmethane OC-carboxylic acid. See Diphenyl acetic acid.
Diphenyl methane diisocyanate. See Methylene-bis(4-phenyl isocyanate).

N,N'-Diphenyl thiourea. See Thiocarbanilide.
1,3-Diphenyl-2-thiourea. See Thiocarbanilide.
1,3-Diphenyltriazine. See alpha-Diazoamidobenzol.
Diphosphorus pentaselenide. See Phosphorus pentaselenide.
Dipping acid. See Sulfuric acid.
Dipropyl amine. See Di-N-propylamine.
Dipropyl ether. See Propyl ether.
Dipropyl methane. See Heptane.
Di-n-propyl sulfate. See Propyl sulfate.
Disiloxane. See Silicyl oxide.
Disodium hydroxy mercury salicyloxyacetate. See "Mercurosal."
Distilled mustard gas. See Dichlorodiethyl sulfide.
Disulfur decafluoride. See Sulfur pentafluoride.
Disulfuric acid. See Pyrosulfuric acid.
Disulfuryl chloride. See Pyrosulfuryl chloride.
2,2'-Dithio-bis-benzothiazole. See 2,2'-Dibenzothiazyl disulfide.
Dithranol. See 1,8-Dihydroxyanthranol.
sym-Di-o-tolythiourea. See Di-ortho-tolylthiourea.
Divinyl ether. See Vinyl ether.
Divinyl oxide. See Vinyl ether.
Dodecane dioic acid. See Sebacic acid.
Dodecanoic acid. See Lauric acid.
Dodecanoyl peroxide. See Lauroyl peroxide.
Dodecyl bromide. See Lauryl bromide.
Dodecyl chloride. See Lauryl chloride.
Dodecylene. See Dodecene.
Dodecyl pyridinium chloride. See Lauryl pyridinium chloride.
Domeykite. See Tri-copper arsenide.
Double nickel salt. See Ammonium nickel sulfate.
"Dowanol 50 B." See Dipropylene glycol monomethyl ether.
Dried grass. See Hay.
Dry ice. See Carbon dioxide, solid.
Duboisine. See Hyoscyamine.
Dumasin. See Cyclopentanone.
E-60. See Ethylene glycol dibenzoate.
EDTN. See Ethylenediamine tetraacetonitrile.
Earthnut oil. See Peanut oil.
Earth oil. See Crude oil (petroleum).
Earth wax. See Ceresin wax.
Echitamine. See Ditaine.
Ekaboron. See Scandium.
Elayl. See Ethylene.
Emerald green. See Copper acetoarsenite.
Epinephrine. See "Adrenaline."
1,2-Epoxyethane. See Ethylene oxide.
1,2-Epoxypropane. See Propylene oxide.
Epsom salt. See Magnesium sulfate.
Ergamine. See Histamine.
Ergotoxine. See Ergotinine.
Erythrene. See Butadiene-1,3.
Erythrite. See Cobaltous o-arsenate.
Eserine. See Physostigmine.
Essential salt of lemon. See Potassium binoxalate.
Ethanedial. See Glyoxal.
1,2-Ethanediamine. See Ethylenediamine.
Ethane dinitrile. See Cyanogen.
Ethanedioic acid. See Oxalic acid.
1,2-Ethanediol. See Ethylene glycol.
Ethanedioyl bromide. See Oxalyl bromide.
Ethanedioyl chloride. See Oxalyl chloride.
Ethanenitrile. See Methyl cyanide.
Ethanethiol. See Ethyl mercaptan.
Ethanethiolic acid. See Thioacetic acid.
Ethanoic acid. See Acetic acid.
Ethanoic anhydride. See Acetic anhydride.
Ethanol. See Ethyl alcohol.
Ethanoyl bromide. See Acetyl bromide.
Ethanoyl chloride. See Acetyl chloride.
Ethanol iodide. See Acetyl iodide.
Ethanoyl peroxide. See Acetyl peroxide.
Ethene. See Ethylene.
Ethenol. See Vinyl alcohol.
Ethenone. See Ketene.
Ethenoxy ethane. See Ethyl vinyl ether.
Ether. See Ethyl ether.
Etherin. See Ethylene.
Ethine. See Acetylene.
Ethinyl trichloride. See Ethylene trichloride; Trichloroethylene.
2-Ethoxy ethanol. See "Cellosolve" solvent.
Ethyl aldehyde. See Acetaldehyde.
Ethyl-p-aminobenzoate. See Anesthesin; Benzocaine.
Ethyl benzol. See Ethylbenzene.
Ethyl bromoethanoate. See Ethyl bromoacetate.
Ethyl butanoate. See Ethyl n-butyrate.
2-Ethyl butanoic acid. See 2-Ethyl butyric acid.
2,2-Ethyl butoxy ethanol. See 2-Ethylbutyl "Cellosolve."
2-Ethyl butyl alcohol. See 2-Ethyl butanol.
2-Ethylbutyric aldehyde. See 2-Ethyl butyraldehyde.
Ethyl cacodyl. See Arsenic diethyl.
Ethyl carbinol. See n-Propyl alcohol.
Ethyl carbonate. See Diethyl carbonate.
Ethyl chloroethanoate. See Ethyl chloroacetate.
Ethyl chloroformate. See Ethyl chlorocarbonate.
Ethyl chloromethanoate. See Ethyl chlorocarbonate.
Ethyl diazoacetate. See Diazoacetic ester.
Ethyl diazoethanoate. See Diazoacetic ester.
Ethylene acetate. See Ethylene glycol diacetate.
Ethylene alcohol. See Ethylene glycol.
Ethylene butyrate. See Ethylene dibutyrate.
Ethylene chloride. See Ethylene dichloride.
Ethylene cyanide. See Succinonitrile.
Ethylenediamine tetracetic acid. See Disodium ethylenediamine tetraacetate.
Ethylene dicarboxylic acid. See Succinic acid.
2,2'-Ethylene dioxydiethanol. See Triethylene glycol.
Ethylene fluoride. See 1,1-Difluoroethane; Ethylene difluoride.
Ethylene formate. See Ethylene glycol diformate; Glycol diformate.
Ethylene glycol monobenzyl. See Benzyl "Cellosolve."
Ethylene glycol monoethyl ether. See "Cellosolve" solvent.
Ethylene glycol monoethyl ether acetate. See "Cellosolve" acetate.
Ethylene glycol monomethyl ether acetate. See Methyl "Cellosolve" acetate.
Ethylene laurate. See Ethylene dilaurate.
Ethylene nitrate. See Ethylene dinitrate; Dinitroglycol.
Ethylene nitrite. See Ethylene dinitrite.
Ethylenesuccinic acid. See Succinic acid.
Ethylene tetrachloride. See Perchloroethylene.
Ethyl ester. See Ethyl acetate.
Ethyl ethanedioate. See Diethyl oxalate.
Ethyl ethanoate. See Ethyl acetate.
2-Ethyl hexanal. See Octyl aldehyde.
2-Ethyl-1-hexanol. See 2-Ethylhexyl alcohol.
2-Ethylhexenal. See 2-Ethyl-3-propyl acrolein.
beta-Ethylhexyl acetate. See 2-Ethylhexyl acetate.
Ethyl hydride. See Ethane.
Ethyl hydrogen sulfate. See Ethylsulfuric acid.
Ethyl hydrosulfide. See Ethyl mercaptan.
Ethyl-2-hydroxy propanoate. See Ethyl lactate.
Ethylidene acetone. See 3-Pentene-2-one.
Ethylidene dichloride. See Ethylidene chloride.
Ethylidene dimethyl ether. See Dimethylacetal.
Ethylidenelactic acid. See Lactic acid.

5-Ethyl-5-isoamylbarbituric acid. See Amobarbital.
Ethylisobutylmethane. See 2-Methylhexane.
Ethyl mercuric chloride. See Ethyl mercury chloride.
Ethyl methanoate. See Ethyl formate.
Ethylmethyl carbinol. See sec-Butyl alcohol.
Ethyl-2-methylpropanoate. See Ethyl isobutyrate.
Ethylmorphine hydrochloride. See Dionin.
Ethyl nitrate spirit. See Spirits of niter, sweet.
1-Ethyl-2-nitrobenzene. See o-Ethyl nitrobenzene.
Ethyl p-nitrobenzoate. See p-Nitrobenzoic acid ethyl ester.
Ethyl oxide. See Ethyl ether.
Ethyl phenyl acetamide. See Ethyl acetanilide.
Ethyl phenyl amine. See N-Ethylaniline.
Ethylphenyl ketone. See Propiophenone.
Ethyl phthalate. See Diethyl o-phthalate.
Ethyl propenoate. See Ethyl acrylate.
Ethyl propionyl. See Diethyl ketone.
1-Ethyl-2-propyl ethylene. See 3-Heptene.
Ethyl propyl ketone. See 3-Hexanone.
Ethyl succinate. See Diethyl succinate.
Ethyl sulfate. See Diethyl sulfate.
Ethyl sulfhydrate. See Ethyl mercaptan.
Ethyl tetraphosphate. See Hexaethyl tetraphosphate.
Ethyl thioalcohol. See Ethyl mercaptan.
Ethyl thiocarbimide. See Ethyl isothiocyanate.
Ethyl urethane. See Ethyl carbamate.
Ethyne. See Acetylene.
Euclase. See Beryllium-aluminum silicate.
F-114. See Dichlorotetrafluoroethane.
F-P Salt No. 4. See Potassium hexafluorophosphate.
Fairy gloves. See Digitalis.
Feraconitine. See Pseudoaconitine.
Fernambuco. See Brazil wood.
Ferrum. See Iron.
Fischer's salt. See Potassium cobaltinitrite.
Fish berry. See Cocculus solid.
"Flexol plasticizer CC-55." See Hexyl diethyl heptylate.
Flowers of sulfur. See Sulfur.
Flowers of zinc. See Zinc oxide.
Fluorhydric acid. See Hydrofluoric acid.
Fluorine analog of DDT. See 1-Trichloro-2,2-bis(p-fluorophenyl) ethane.
Fluoroethane. See Ethyl fluoride.
Fluoroformyl fluoride. See Carbonyl fluoride.
Fluoroisopropoxymethyl-phosphine oxide. See Sarin.
Fluoroisopropyl alcohol. See Propylene fluorohydrin.
Fluoromethane. See Methyl fluoride.
Fluoromethyl pinacolyl-oxyphosphine oxide. See Soman.
3-Fluoropropene. See Allyl fluoride.
Fluosulfuric acid. See Fluosulfonic acid.
Formal. See Methylal.
Formaldehyde cyanohydrin. See Glycolonitrile.
Formaldehyde dimethylacetal. See Methylal.
Formalin. See Formaldehyde (commercial solutions).
Formamine. See Hexamethylenetetramine.
Formic ether. See Ethyl formate.
Formyl hydroperoxide. See Performic acid.
Foxglove. See Digitalis.
Fremy's salt. See Potassium bifluoride.
French chalk. See Talc.
"Freon 11." See Fluorotrichloromethane.
"Freon 12." See Dichlorodifluoromethane.
"Freon 21." See Dichlorofluoromethane.
Fuel oil No. 1. See Kerosene.
Fuel oil No. 2. See Diesel oil.
Fuming sulfuric acid. See Oleum.
Fural. See Furfural.
2-Furaldehyde. See Furfural; Pyromucic aldehyde.
Furale. See Furfural.
2-Furancarbonal. See Furfural.
2-Furanmethylamine. See Furfurylamine.
Furfurane. See Furan.
Fusel oil. See Isoamyl alcohol, primary.
G-4. See 2,2'-Dihydroxy-5,5'-dichlorodiphenylmethane.
Galena. See Lead sulfide.
Gallium selenide. See Gallium monoselenide.
Galloethane. See Gallium hydride.
Gallotannic acid. See Tannic acid.
"Gardenia oxide." See Amyl benzyl ether.
Garlic oil. See Allyl sulfide.
Gashouse tankage. See Spent oxide.
Germanium bromoform. See Tribromogermane.
Germanium chloroform. See Trichlorogermane.
Germanium hydride. See Digermane; Trigermane.
Germanium tetrahydride. See Monogermane.
Glucinum. See Beryllium.
Glucinum potassium fluoride. See Beryllium potassium fluoride.
Glucinum sodium fluoride. See Beryllium sodium fluoride.
Glycerol. See Glycerine.
Glycerol trichlorohydrin. See 1,2,3-Trichloropropane.
Glycerol trinitrate. See Nitroglycerin.
Glyceryl tributyrate. See Tributyrin.
Glycol. See Ethylene glycol.
Glycol alcohol. See Ethylene glycol.
Glycol bis(hydroxyethyl) ether. See Triethylene glycol.
Glycol carbonate. See Ethylene carbonate.
Glycol chlorohydrin. See Ethylene chlorohydrin.
Glycol cyanohydrin. See Ethylene cyanohydrin.
Glycol diabietate. See Ethylene glycol diabietate.
Glycol diacetate. See Ethylene glycol diacetate.
Glycol dibromide. See Ethylene dibromide.
Glycol diformate. See Ethylene glycol diformate.
Glycolic. See Hydroxyacetic acid.
Glycol monoacetate. See Ethylene glycol monoacetate.
Glycol monobutyl ether. See Butyl "Cellosolve."
Glycol monobutyl ether acetate. See Butyl "Cellosolve" acetate.
Glycoluril. See Acetylene diureine.
Glyodin. See 2-Heptadecyl glyoxaldine acetate.
Goa powder. See Chrysarobin.
Goat hair. See Mohair.
Gold cyanide. See Aurous cyanide.
Gold nitrate. See Auric hydrogen nitrate.
Gold oxide. See Auric oxide.
Gold sulfide. See Auric sulfide.
Greenockite. See Cadmium sulfide.
Green oil. See Anthracene.
Green vitriol. See Ferrous sulfate.
Guanajuatite. See Bismuth triselenide.
Guanylnitrosoaminoguanyltetrazene. See Tetracine; Tetrazene.
Guaza. See Cannabis.
Gum arabic. See Acacia gum.
Gum camphor. See Camphor.
Gum copal. See Copal.
Gum opium. See Opium.
Gum rosin. See Rosin.
Gum thus. See Turpentine(gum).
Gum tragacanth. See Tragacanth.
Guncotton. See Nitrocellulose.
Gunpowder. See Explosives, low.
HD. See Dichlorodiethyl sulfide.
HEPT. See Hexaethyl tetraphosphate.
HN-1. See Nitrogen mustard.
Hafnia. See Hafnium oxide.

Hafnium dioxide. See Hafnium oxide.
Halite. See Sodium chloride.
Hamamelis. See Witch hazel.
Hambergite. See Beryllium o-borate, basic.
Hashish. See Cannabis.
Heazlewoodite. See Nickel subsulfide.
Helianthine B. See Methyl orange.
Heliotropin. See Piperonal.
Hendecanal. See Undecanal.
"Hepar calcis." See Calcium sulfide.
Hepar sulfuris. See Potassium sulfide.
Heptadecyl alcohol. See Heptadecanol.
2-Heptadecylglyoxalidine. See 2-Heptadecylimidazoline.
3-Heptanecarboxylic acid. See 2-Ethyl hexoic acid.
4-Heptanone. See Butyrone.
Heptyl alcohol. See 1-Heptanol.
Heptyl hydride. See Heptane.
Heroin. See Diacetyl morphine.
Hexaboron decahydride. See Hexaborane.
Hexabromodisilane. See Disilicon hexabromide.
Hexachlorocyclohexane. See Benzene hexachloride.
Hexachlorodisilane. See Disilicon hexachloride.
1, 2, 3, 4, 10, 10-Hexachloro-6, 7-epoxy-1, 4, 4a, 5, 6, 7, 8, 8a-octahydro-1, 4, 5, 8-dimethanonaphthalene. See Dieldrin.
1, 2, 3, 4, 10, 10-Hexachloro-1, 4, 4a, 5, 8, 8a-hexahydro-1, 4, 5, 8-dimethanonaphthalene. See Aldrin.
Hexadecanol. See Cetyl alcohol.
Hexadecyl acetylene. See 1-Octadecene.
1-Hexadecyne. See 1-Hexadecine.
2, 4-Hexadienoic acid. See Sorbic acid.
1, 5-Hexadiyne. See Dipropargyl.
Hexafluorodisilane. See Disilicon hexafluoride.
Hexahydroaniline. See Cyclohexylamine.
Hexahydrobenzene. See Cyclohexane.
Hexahydrocresol. See Methyl cyclohexanol.
Hexahydromethyl phenol. See Methyl cyclohexanol.
Hexahydrophenol. See Cyclohexanol.
Hexahydropyrazine. See Piperazine.
Hexahydropyridine. See Piperidine.
Hexahydrothymol. See Menthol.
Hexahydrotoluene. See Methylcyclohexane.
Hexahydro-1, 3, 5-triphenyl-sym-triazine. See Methylene aniline.
Hexahydroxyl. See p-Dimethylcyclohexane.
Hexaiododisilane. See Disilicon hexaiodide.
Hexalin acetate. See Cyclohexyl acetate.
Hexamethylene. See Cyclohexane.
Hexamethylene glycol. See Hexanediol-1, 6.
Hexamine. See Hexamethylenetetramine; Hexanitrodiphenylamine.
γ-Hexane. See Benzene hexachloride.
1, 6-Hexanediamine. See Hexamethylenediamine.
Hexane dioic acid. See Adipic acid.
Hexanedione-2, 5. See Acetonyl acetone.
1, 2, 3, 4, 5, 6-Hexane hexanitrate. See Dulcitol hexanitrate.
2, 4, 6, 2', 4', 6'-Hexanitrodiphenylamine. See Dipicryl amine.
Hexanoic acid. See Caproic acid.
Hexanol. See Amyl carbinol.
2-Hexanone. See Methyl n-butyl ketone.
Hexene. See Hexene-1.
5-Hexene-2-one. See Allyl acetone.
Hexil. See Hexanitrodiphenylamine.
Hexite. See Hexanitrodiphenylamine.
Hexogen. See Cyclotrimethylene trinitramine; Trimethylene trinitramine.
Hexyl acetate. See Methyl amylacetate.
Hexyl adipate. See Dihexyl adipate.
n-Hexyl alcohol. See Amyl carbinol; 1-Hexanol.
Hexylene. See Hexene-1.
Hexyl hydride. See n-Hexane.
Hexyl titanate. See 2-Ethyl butyl titanate.
Hieratite. See Potassium fluosilicate.
Hi-flash naphtha. See Naphtha(coal tar).
Hoernesite. See Magnesium o-arsenate.
Hydracrylonitrile. See Ethylene cyanohydrin.
Hyrated lead oxide. See Lead hydroxide.
Hydrated lime. See Calcium hydroxide.
Hydrazine base. See Hydrazine.
Hydriodic ether. See Ethyl iodide.
Hydrobromic ether. See Ethyl bromide.
Hydrocerussite. See Lead carbonate, basic.
Hydrochloric ether. See Ethyl chloride.
Hydrogen-3. See Tritium.
Hydrogen bromide. See Hydrobromic acid.
Hydrogen carboxylic acid. See Formic acid.
Hydrogen chloride. See Hydrochloric acid.
Hydrogen cyanide. See Hydrocyanic acid.
Hydrogen dioxide. See Hydrogen peroxide.
Hydrogen fluoride. See Hydrofluoric acid.
Hydrogen nitrate. See Nitric acid.
Hydrogen phosphide. See Phosphine.
Hydrolith. See Calcium hydride.
Hydronium perchlorate. See Perchloric acid, monohydrate.
Hydroquinol. See p-Hydroquinone.
Hydroquinone in oil. See Antiseptic oil.
p-Hydroxy aniline. See p-Aminophenol.
Hydroxy anisole. See Hydroquinone monomethyl ether.
o-Hydroxybenzoic acid. See Salicylic acid.
1-Hydroxy-3, 5-dimethyl benzene. See 3, 5-Xylenol.
5-Hydroxy-1, 3-dimethyl benzene. See 3, 5-Xylenol.
1-Hydroxy-2, 3-dinitrobenzene. See 2, 3-Dinitrophenol.
(2-Hydroxydiphenyl) methane. See o-Benzyl phenol.
(4-Hydroxydiphenyl) methane. See p-Benzyl phenol.
Hydroxyethanoic acid. See Glycolic acid.
(2-Hydroxyethyl) ethylenediamine. See 2-Amino ethyl ethanol amine.
1-Hydroxyethyl-1, 2-heptadecenyl glyoxaldene. See Cationic amine 200.
2-Hydroxyethyl mercaptan. See Mercaptoethanol.
Hydroxylammonium chloride. See Hydroxylamine hydrochloride.
Hydroxylammonium sulfate. See Hydroxylamine acid sulfate.
4-Hydroxy-4-methylpentanone-2. See Diacetone.
α-Hydroxynaphthalene. See α-Naphthol.
β-Hydroxynaphthalene. See β-Naphthol.
3-Hydroxy-β-naphthoic acid. See 2-Naphthol-3-carboxylic acid.
2-Hydroxy-2, 4, 4, 4, 7-pentamethylflavan. See Hydroxypentamethylflavan.
2-Hydroxypropanenitrile. See Lactonitrile.
β-Hydroxypropionitrile. See Ethylene cyanohydrin.
Hydroxytoluene. See Benzyl alcohol.
o-Hydroxytoluene. See o-Cresol.
α-Hydroxy-o-toluic acid lactone. See Phthalide.
β-Hydroxytricarballylic acid. See Citric acid.
1-Hyoscyamine. See Hyoscyamine.
Hypnone. See Phenyl methyl ketone.
Hypo. See Sodium thiosulfate.
Hypochlorous anhydride. See Chlorine tetroxide.
Hyponitrous ether. See Ethyl nitrite.
Hypovanadic hydrochloride. See Vanadium oxydichloride.
4-Imidazole ethylamine. See Histamine.
Imperial green. See Copper acetoarsenite.
Indalone. See Butyl mesityl oxide.
Indian aconite. See Aconitum ferox.

Indian cannabis. See Cannabis.
Indian hemp. See Cannabis.
India rubber. See Rubber, curde.
Infusorial earth. See Diatomaceous earth.
Insoluble cyanuric acid. See Cyamelide.
Iodine dioxide. See Iodine oxide.
Iodine hydroxide. See Hypoiodous acid; Iodous hypoacid.
Iodine tetroxide. See Iodine oxide.
p-Iodoanisole. See Isoform.
Iodoethane. See Ethyl iodide.
Iodomethane. See Methyl iodide.
1-Iodopropane. See Propyl iodide.
3-Iodopropene. See Allyl iodide.
α-Iodotoluene. See Benzyl iodide.
Ipecacuanha. See Ipecac.
Iron arsenide. See Ferric arsenide.
Iron diarsenide. See Ferric diarsenide.
Iron fluoride. See Ferric fluoride.
Iron formate. See Ferric formate.
Iron sulfate. See Ferrous sulfate.
Iron m-vanadate. See Ferric m-vanadate.
Isoamyl hydride. See Isopentane.
3-Isoamyl-5-(methylene dioxyphenyl)-2-cyclohexanone. See Piperonyl cyclonene.
Isoamyl nitrite. See Amyl nitrite.
Isobutanol. See Isobutyl alcohol.
Isobutanolamine. See 2-Amino-2-methyl-1-propanol.
Isobutene. See Isobutylene.
Isobutyl carbinol. See Isoamyl alcohol, primary; Isoamyl alcohol, secondary.
Isobutylmethylcarbinol. See 4-Methyl pentanol-2.
Isobutyraldehyde. See Isobutyl aldehyde.
Isobutyric ether. See Ethyl isobutyrate.
Isocyanic acid. See Cyanic acid; Thiocyanic acid
1, 3-Isoindole dione. See Phthalimide.
Isomer of Yohimbine. See Yohimbene.
Isopropanol. See Isopropyl alcohol.
2-Isopropoxypropane. See Isopropyl ether.
Isopropylcarbinol. See Isobutyl alcohol.
Isopropyl-m-chlorocarbanilate. See Isopropyl N-(3-chlorophenyl) carbamate.
Isopropyl methanoate. See Isopropyl formate.
1-Isopropyl-2-methyl ethylene. See 4-Methyl-2-pentene.
Isopropyl toluene. See p-Cymene.
Isovaleraldehyde. See Isovaleric aldehyde.
Isovalerone. See Diisobutyl ketone.
Juniper tar. See Cade oil.
Katchung oil. See Peanut oil.
Kermes mineral. See Antimony, sulfurated.
Keten. See Ketene.
β-Ketobutyranilide. See Acetoacetanilide.
Ketocyclopentane. See Cyclopentanone.
β-Ketoglutaric acid. See Acetonedicarboxylic acid.
Ketohexamethylene. See Cyclohexanone.
Ketone propane. See Acetone.
Kieselguhr. See Diatomaceous earth.
Kings green. See Copper acetoarsenite.
Kolker acaricide. See p-Chlorophenyl-p-chlorobenzene sulfonate.
L P gas. See Liquefied hydrocarbon gas.
Lactide. See 3, 6-Dimethyl-2, 5-p-dioxanedione.
Lanthana. See Lanthanum oxide.
Lanthanum hexaboride. See Lanthanum boride.
Lanthanum trioxide. See Lanthanum oxide.
Larkspur. See Delphinium.
Laudanidine. See Tritopine.
Laughing gas. See Nitrous oxide.
dl-Laundanine. See Laudanine.
Laurel camphor. See Camphor.
Laurite. See Ruthenium sulfide.
Lawrencite. See Ferrous chloride.
Lead m-arsenate. See Lead arsenate.
Lead o-arsenate. See Lead arsenate.
Lead m-arsenite. See Lead arsenite.
Lead o-arsenite. See Lead arsenite.
Lead di-o-arsenate. See Lead arsenate.
Lead hydrate. See Lead hydroxide.
Lead hyposulfite. See Lead thiosulfate.
Lead mono-o-arsenate. See Lead arsenate.
Lead oxide, yellow. See Litharge.
Lead peroxide. See Lead dioxide.
Lead protoxide. See Litharge.
Lead pyroarsenate. See Lead arsenate.
Lead silicate. See Lead m-silicate.
Lead styphnate. See Lead trinitroresorcinate.
Lead thiocyanate. See Lead sulfocyanate.
Lead wolframate. See Lead tungstate.
Leukol. See Quinoline.
Light ligroin. See Petroleum spirits.
Lime uranite. See Autunite.
Lindane. See Benzene hexachloride.
Liquid camphor. See Camphor oil(light).
Liquid carbonic gas. See Liquefied carbon dioxide.
Liquid rosin. See Tall oil.
Lithic acid. See Uric acid.
Lithium m-aluminate. See Lithium aluminate.
Lithium o-arsenate. See Lithium arsenate.
Lithium bichromate. See Lithium dichromate.
Lithium borate. See Lithium m-borate.
Lithium silicofluoride. See Lithium fluosilicate.
Lye. See Sodium hydroxide.
MBDSA. See m-Benzenedisulfonic acid.
MD. See Dichloromethyl arsine.
Macquer's salt. See Potassium arsenate.
Magnesium dioxide. See Magnesium peroxide.
Maleanilic acid. See N-Phenylmaleamic acid.
Male fern. See Aspidium.
Maleinic acid. See Maleic acid.
Malonic acid mononitrile. See Cyanoacetic acid.
Malonic ester. See Ethyl malonate.
Malonic ethyl ester nitrile. See Ethyl cyanoacetate.
Malonylurea. See Barbituric acid.
Mandelonitrile. See Benzaldehyde cyanhydrin.
Mandelytropeine. See Homatropine and compounds.
Manganese benzoate. See Manganous benzoate.
Manganese bromide. See Manganese dibromide.
Manganese chloride. See Manganese dichloride.
Manganese fluoride. See Manganese difluoride.
Manganese green. See Barium manganate.
Manganese iodide. See Manganese diiodide.
Manganese oxalate. See Manganous oxalate.
Manganese oxide. See Manganese dioxide.
Manganese pyrophosphate. See Manganous pyrophosphate.
Manganese selenite. See Manganous selenite.
Manganese sulfate. See Manganous sulfate.
Manganese tartrate. See Manganous tartrate.
Manganolangbeinite. See Potassium manganous sulfate.
Manganous silicofluoride. See Manganous fluosilicate.
Mangus' salt. See Tetrammine platinum (II) chloroplatinate.
Mannitol nitrate. See Mannitol hexanitrate.
Marihuana. See Cannabis.
Marsh gas. See Methane.
Marshite. See Cuprous iodide.
Matlockite. See Lead oxychloride.
Mechlorethamine hydrochloride. See 2, 2-Dichloro-N-methyl diethylamine hydrochloride.
Melanilic acid. See Aniline sodium sulfonate.
Mendipite. See Lead oxychloride.
Merbromin. See "Mercurochrome."
Mercaptoacetic acid. See Thioglycolic acid.
2-Mercaptoethanoic acid. See Thioglycolic acid.

Mercuric o-phosphate. See Mercuric phosphate.
Mercuric thiocyanate. See Mercuric sulfocyanate.
Mercury p-aminophenol arsenate. See Mercury atoxylate.
Mercury ethylenediaminesulfate. See Sublamin.
Mercury oleate. See Mercuric oleate.
Mercury rhodanide. See Mercuric sulfocyanate.
Mercury subsalicylate. See Mercuric salicylate.
Metaborate peroxyhydrate. See Sodium perborate.
Metacetone. See Diethyl ketone.
Metacinnabarite. See Mercuric sulfide, black.
Metanilic acid, sodium salt. See Aniline sodium sulfonate.
β-Methacrylic acid. See Crotonic acid.
1, 4 (8)-p-Methadiene. See Terpinolene.
Methanal. See Formaldehyde (commercial solutions).
Methanamide. See Formamide.
Methanecarbothiolic acid. See Thiocetic acid.
Methane carboxylic acid. See Acetic acid.
Methanethiol. See Methyl mercaptan.
Methanoic acid. See Formic acid.
Methanol. See Methyl alcohol.
Metheneamine. See Hexamethylenetetramine.
Methoxyacetyl-p-phenetidine. See Kryofin.
Methoxy analog of DDT. See 1-Trichloro-2, 2-bis (p-methoxyphenyl) ethane.
o-Methoxyaniline. See o-Anisidine.
p-Methoxyaniline. See p-Anisidine.
Methoxyethane. See Ethyl methyl ether.
2-Methoxy-4-nitroaniline. See 1-Amino-2-methoxy-4-nitrobenzene; 4-Nitro-o-anisidine.
4-Methoxy phenol. See Hydroquinone monomethyl ether.
1-Methoxy-2-propanol. See Monopropylene glycol methyl ether.
Methyl acetic acid. See Propionic acid.
α-Methylacrolein. See Methacrolein.
β-Methylacrolein. See Crotonaldehyde.
α-Methylacrylic acid. See Methacrylic acid.
Methyl aldehyde. See Formaldehyde (commercial solutions).
Methylallene. See Butadiene-1, 3.
Methyl amyl ketone. See 2-Heptanone.
m-Methylaniline. See m-Toluidine.
o-Methylaniline. See o-Toluidine.
p-Methylaniline. See p-Toluidine.
Methyl arsenic dichloride. See Dichloromethyl arsine; Methyl dichloroarsine.
Methylbenzene. See Toluene.
Methyl benzene sulfonic acid. See Toluene sulfonic acid.
Methylbenzoylecgonine. See Cocaine.
o-Methyl benzyl bromide. See o-Xylyl bromide.
o-Methyl benzyl chloride. See o-Xylyl chloride.
3-Methyl 1, 3-butadiene. See Isoprene.
3-Methylbutanal. See Isovaleric aldehyde.
2-Methyl butane. See Isopentane.
2-Methyl-2-butanol. See tert-Amyl alcohol, refined.
2-Methyl-3-butyn-2-ol. See Methyl butynol.
Methyl carbinol. See Ethyl alcohol.
Methyl catechol. See Guaiacol.
Methylchlorobenzene. See Monochlorotoluene.
Methyl chlorocarbonate. See Methyl chloroformate.
Methyl chloroform. See α-Trichloroethane.
Methyl chloromethanoate. See Methyl chloroformate.
Methyl cyanoethanoate. See Cyanomethyl acetate.
Methyl cyclohexanol acetate. See Methyl cyclohexyl acetate.
4-Methyl-2, 6-di-tert butyl phenol. See Di-tert-butyl-p-cresol.
Methyl dichloroethanoate. See Methyl dichloroacetate.
2-Methyl-4, 6-dinitrophenol. See 4, 6-Dinitro-o-cresol.
2, 2'-Methylene bis (4-chlorophenol). See 2, 2' Dihydroxy-5, 5'-dichlorodiphenylmethane.
Methylene dimethyl ether. See Methylal.
3, 4-Methylene-dioxybenzaldehyde. See Piperonal.
Methylene succinic acid. See Itaconic acid.
Methyl ether. See Dimethyl ether.
sym-Methylethylethylene. See 2-Pentene.
Methylethyl ketone. See Butanone; Ethyl methyl ketone.
Methylethylmethane. See Butane.
Methyl hydride. See Methane.
Methyl isonitrile. See Methyl isocyanide.
Methylmethane. See Ethane.
Methyl methanoate. See Methyl formate.
Methylmorphine. See Codeine.
Methyl nitrobenzene. See p-Nitrotoluene.
Methyl oxide. See Dimethyl ether; Methyl ether.
Methyl oxirane. See Propylene oxide.
4-Methyl-2-pentanone. See Hexone; Methyl isobutyl ketone.
4-Methyl-3-penten-2-one. See Mesityl oxide.
3-Methyl-1-pentyn-3-ol. See Methyl pentynol.
m-Methyl phenol. See m-Cresol.
4-Methyl phenyl 2-acetate. See Methyl amylacetate.
Methyl phenyl carbinol. See α-Methyl benzyl alcohol; Phenylmethyl carbinol.
Methyl phenyl ketone. See Phenyl methyl ketone.
2-Methyl-2-phenyl propane. See tert-Butyl benzene.
Methyl picrate. See Trinitroanisol.
2-Methyl propane. See Isobutane.
2-Methyl-2-propanethiol. See tert-Butyl mercaptan.
2-Methyl propanol. See Isobutyl aldehyde.
2-Methyl-2-propanol. See tert-Butyl alcohol.
2-Methyl-1-propanol. See Isobutyl alcohol.
2-Methyl propene. See Isobutylene.
2-Methyl propenenitrile. See Methacrylonitrile.
1-Methyl-1-propyl ethylene. See 2-Methyl-1-pentene.
Methyl propyl ketone. See Pentanone-2.
α-Methyl propyl nitrate. See sec-Butyl nitrate.
α-Methyl propyl nitrite. See sec-Butyl nitrite.
2-Methyl pyridine. See α-Picoline.
3-Methyl pyridine. See β-Picoline.
4-Methyl pyridine. See γ-Pyridine.
1-Methyl-2-pyrrolidone. See N-Methyl-2-pyrrolidone.
Methyl sebacate. See Dimethyl sebacate.
Methyl selenide. See Dimethyl selenide.
Methyl sulfate. See Dimethyl sulfate.
Methyl 1, 2, 5, 6-tetrahydro-1-methyl nicotinate. See Arecoline base.
1-N-Methyltetrahydropapaverine. See Laudanosine.
Methylthiomethane. See Methyl sulfide.
Methyltriphenylsilane. See Methyl triphenylsilicone.
N-Methyltropoline. See Tropine.
Methylvinyl ketone. See 3-Pentene-2-one.
Millerite. See Nickel monosulfide.
Mineral oil, No. 2. See Lard oil, pure.
Mineral wax. See Ceresin wax; Ozokerite.
Minium. See Lead oxide.
Molybdenite. See Molybdenum sulfide.
Molybdenum dichloride. See Molybdenum chloride.
Molybdenum disulfide. See Molybdenum sulfide.
Molybdenum sesquioxide. See Molybdenum oxide.

Molybdic sulfide. See Molybdenum sulfide.
Monkshood. See Aconite.
Monochlorated acetone. See Monochloroacetone, stabilized.
Monochlorobenzene. See Chlorobenzene.
Monochlorobromomethane. See Monochloromonobromomethane.
Monochloroethylene chloride. See Ethylene monochlorochloride.
Monochlorotrifluoroethylene. See Trifluorochloroethylene.
Monododecyl benzene. See Keryl benzene-12.
Monoethylamine. See Ethylamine.
Monomethylaniline. See N-Methylaniline.
Montanite. See Bismuth tellurate.
Morphine benzyl ether hydrochloride. See Peronine.
Mossbunker oil. See Menhaden oil.
Moss green. See Copper acetoarsenite.
Moth flakes. See Naphthalene.
Mountain tobacco. See Arnica.
Muriatic acid. See Hydrochloric acid.
Muriatic ether. See Ethyl chloride.
NBA. See N-Bromoacetamide.
NIS. See Iodosuccinimide.
Nantokite. See Cuprous chloride.
Naphtha, 76°. See Naphtha, VM&P.
Naphthacene. See Tetracene.
p-Naphthalene. See Anthracene.
Naphthalene ethylene. See Acenaphthene.
1-Naphthol. See α-Naphthol.
β-Naphthol. See β-Naphthol.
α-Naphthol-1,2,3,4-tetrahydride. See Tetrahydronaphthol.
Naples yellow. See Lead antimonate.
Natrium. See Sodium.
Navy special. See Fuel oil No. 5.
Neonicotine. See Anabasine.
Neonicotine sulfate. See Anabasine sulfate.
Neopentane. See 2,2-Dimethylpropane.
Neosalvarsan. See Neoarsphenamine.
Nepaline. See Pseudoaconitine.
Neutral verdigris. See Copper acetate.
Niccolite. See Nickel arsenide.
Nickel o-arsenate. See Nickel arsenate.
Nickelic hydroxide. See Nickel hydroxide.
Nickelic oxide. See Nickel peroxide.
Nickel nitrate tetraamine. See Nickel ammonium nitrate.
Nickelous bromide. See Nickel bromide.
Nickelous phosphate. See Nickel phosphate.
Nicotine isomer. See Anabasine.
Niobe oil. See Methyl benzoate.
Niobium pentachloride. See Niobium chloride.
Niter. See Potassium nitrate.
Niton. See Radon.
n-Nitraniline. See m-Nitroaniline.
o-Nitraniline. See o-Nitroaniline.
Nitratine. See Sodium nitrate.
Nitre. See Potassium nitrate.
Nitric acid, anhydrous. See Nitric acid, fuming.
Nitric anhydride. See Nitrogen pentoxide.
Nitric ether. See Ethyl nitrate.
Nitrilomalonamide. See Cyanoacetamide.
Nitrilotrisilane. See Trisilicylamine.
5-Nitro-2-aminoanisole. See 1-Amino-2-methoxy-4-nitrobenzene.
5-Nitro-2-aminoanisole. See 2-Methoxy-4-nitroaniline; 4-Nitro-o-anisidine.
Nitrobarite. See Barium nitrate.
Nitrobenzol. See Nitrobenzene.
Nitrobromoform. See Bromopicrin.
o-Nitrochlorobenzene. See o-Chloronitrobenzene.
Nitrocotton. See Nitrocellulose.
o-Nitrodiphenyl. See o-Nitrobiphenyl.
Nitrogen oxychloride. See Nitrosyl chloride.
Nitrogen oxyfluoride. See Nitrosyl fluoride.
Nitrogen tetroxide. See Nitrogen dioxide.
Nitrogen tribromide. See Nitrogen bromide.
Nitrogen trichloride. See Nitrogen chloride.
Nitrohydrochloric acid. See Aqua regia.
Nitromannitol. See Nitromannite.
Nitromethane. See Nitroparaffins.
Nitrosugar. See Nitrosaccharose.
Nitrotrichloromethane. See Chloropicrin.
m-Nitrotrifluoromethyl benzene. See m-Nitrobenzotrifluoride.
Nitrous anhydride. See Dinitrogen trioxide.
Nitrous ether. See Ethyl nitrite.
n-Nitroxylene. See m-Nitroxylol.
o-Nitroxylene. See o-Nitroxylol.
p-Nitroxylene. See p-Nitroxylol.
Nonyl alcohol. See Diisobutyl carbinol.
Nonyl benzene. See Nonylbenzol.
Nonyl carbinol. See n-Decyl alcohol.
OCPN. See o-Chloro-p-nitroaniline.
OMPA. See Octamethyl pyrophosphoramide.
ONB. See o-Nitrobiphenyl.
1,2,4,5,6,7,8,8-Octachloro-4,7-methano-3a,4,7,7a-tetrahydroindane. See Chlordane.
Octadecanoic acid. See Stearic acid.
1-Octadecanol. See Stearyl alcohol.
1-Octadecyne. See 1-Octadecene.
4,5-Octanediol. See Octylene glycol.
1-Octanol. See Octyl alcohol.
2-Octanol. See Capryl alcohol.
Octanoyl chloride. See Caprylyl chloride.
Octoic anhydride. See 2-Ethyl hexanoic anhydride.
Octyl acetate. See 2-Ethylhexyl acetate.
1-Octylene. See 1-Octene.
Octyl titanate. See 2-Ethylhexyl titanate.
Oil of amber. See Amber oil.
Oil of American wormseed. See Oil of chenopodium.
Oil of citronella (Ceylon). See Citronella.
Oil of crisp mint. See Spearmint oil.
Oil of mirbane. See Nitrobenzene.
Oil of tansy. See Tansy oil.
Oil of vitriol. See Sulfuric acid.
Oil of wintergreen. See Methyl salicylate.
Oldhamite. See Calcium sulfide.
Onion oil. See Allyl propyl disulfide.
Orange III. See Methyl orange.
Ordeal bean. See Physostigma.
Orpiment. See Arsenic trisulfide.
Orthoformic ester. See Triethyl-o-formate.
Orthoxenol. See o-Phenylphenol.
Osmic acid. See Osmium tetraoxide.
Oxalaldehyde. See Glyoxal.
Oxalic ether. See Diethyl oxalate; Ethyl oxalate.
Oxammonium. See Hydroxylamine.
Oxindole. See 2(3)-Indolone.
Oxoate. See Amiodoxyl benzoate.
2-Oxohexamethylenimine. See ε-Caprolactam.
Oxole. See Furan.
Oxybutyric aldehyde. See Aldol.
Oxyisobutyric nitrile. See Acetone cyanhydrin.
β-Oxymethyl-β-pyridyl-propionic acid. See Ecgonine.
β-Oxynaphthoic acid. See 3-Hydroxy-2-naphthoic acid; 2-Naphthol-3-carboxylic acid.
Oxyquinoline potassium sulfate. See Quinosol.
22-PB. See 2,2-bis(tert-Butylperoxy) butane.
PETN. See Pentaerythritol tetranitrate.
PF. See Perchloryl fluoride.
PMA. See Pyromellitic acid.
Palm butter. See Palm oil.
Palm nut oil. See Palm kernel oil.
Paraform. See Paraformaldehyde.
Paramorphine. See Thebaine.
Paraperiodic acid. See Periodic acid.
Parmelaconite. See Copper oxide.
Pear oil. See Amyl acetate.
Pelargonic acid. See Nonanoic acid.

Peligot's salt. See Potassium chlorochromate.
"Peneteck." See Pentaerythritol, technical.
Pentaboranide. See Potassium pentaborane.
Pentaboron enneahydride. See Pentaborane, stable.
Pentalin. See Pentachloroethane.
Pentamethylene. See Cyclopentane.
Pentamethylene glycol. See 1, 5-Pentanediol.
1-Pentanethiol. See Amyl mercaptan.
1-Pentanol. See Amyl alcohol.
2-Pentanol. See Methylpropylcarbinol.
3-Pentanol. See sec-n-Amyl alcohol.
3-Pentanone. See Diethyl ketone.
"Pentek." See Pentaerythritol, technical.
2-Pentene-3-carboxylic acid. See Ethyl crotonate.
Pentylcarbinol. See Amyl carbinol.
Pentyl propanoate. See Amyl propionate.
Perchloric acid dihydrate. See Perchloric acid (over 72%).
Perchlorobenzene. See Hexachlorobenzene.
Perfluoroethylene. See Tetrafluoroethylene, inhibited.
Pernambuco. See Brazil wood.
Peroxyacetic acid. See Peracetic acid.
Persulfurheptoxide. See Sulfur heptoxide.
Persulfuric acid. See Peroxydisulfuric acid.
Peruvian balsam. See Balsam of Peru.
Petrol. See Gasoline.
Petroleum benzine. See Benzine; Petroleum spirits.
Petroleum ether. See Benzine; Naphtha (petroleum); Petroleum spirits.
Petroleum naphtha. See Petroleum spirits.
Petroleum pitch. See Asphalt.
Petryl. See Trinitrophenylnitramine ethyl nitrate.
β-Phellandrene. See 1(7), 2-p-Menthadiene.
Phenacetin. See Acetophenetidine.
Phenacyl bromide. See Bromoacetophenone.
Phenacylchloride. See Chloroacetophenone.
Phenacyl fluoride. See Fluoroacetophenone.
Phenic acid. See Phenol.
2-Phenoxyethyl acetate. See Ethylene glycol phenyl ether acetate.
Phenozone. See Antipyrine.
N-Phenylacetamide antifebrin. See Acetanilide.
Phenylamine. See Aniline.
Phenylaniline. See Diphenylamine.
p-Phenylazoaniline. See p-Aminoazobenzene.
Phenylbenzoyl carbinol. See Benzoin.
Phenylbiguanide, free base. See Phenylbiguanide.
m-Phenyl biphenyl. See m-Terphenyl.
Phenyl bromide. See Bromobenzene.
1-Phenyl butane. See Butyl benzene.
2-Phenyl butane. See sec-Butyl benzene.
Phenyl carbinol. See Benzyl alcohol.
Phenyl chloride. See Chlorobenzene.
Phenylchloromethylketone. See Chloroacetophenone.
Phenyl cyanide. See Benzonitrile.
Phenyl dichlorophosphine. See Benzene phosphorus dichloride.
Phenyl dichlorophosphine oxide. See Benzene phosphorus oxydichloride.
Phenyl dichlorophosphine sulfide. See Benzene phosphorus thiodichloride.
Phenylethane. See Ethylbenzene.
1-Phenylethanol. See Phenylmethyl carbinol.
2-Phenylethanol. See Phenethyl alcohol.
Phenylethylbarbituric acid. See "Luminal."
Phenylethyl carbamate. See Phenylurethane.
Phenylethylene oxide. See Styrene oxide.
5, 5-Phenylethylhydantoin. See Nirvanol.
Phenylethylmalonylurea. See "Luminal."
Phenylformic acid. See Benzoic acid.
Phenyl hydride. See Benzene.
Phenyl α-hydroxybenzyl ketone. See Benzoin.
Phenylic acid. See Phenol.
Phenyliminophosgene. See Phenyl carbylamine chloride.
Phenylisothiocyanate. See Phenyl mustard oil.
Phenyl ketone. See Benzophenone.
Phenyl mercury urea. See "Leytosan."
Phenylmethane. See Toluene.
Phenylmethane thiol. See Benzyl mercaptan.
1-Phenyl-2-methylamino propanol. See Ephedrine.
Phenyl methyl ether. See Anisole.
Phenyl methyl ketone. See Acetophenone.
N-Phenylmorpholine. See 4-Phenylmorpholine.
N-Phenyl-2-naphthylamine. See Phenyl β-naphthylamine.
1-Phenylpropane. See n-Propyl benzene.
2-Phenylpropane. See Cumene.
Phenylthiocarbamide. See Phenylthiourea.
Phenylthiocarbonimide. See Phenyl mustard oil.
Phlorizin. See Phloridizin.
Phosphaniline. See Phenyl phosphine.
Phosphinoethane. See Ethyl phosphine.
Phosphoretted hydrogen. See Phosphine.
Phosphoric acid anhydride. See Phosphorus pentoxide.
Phosphorus chloride. See Phosphorus trichloride.
Phosphorous sulfochloride. See Thiophosphoryl chloride.
Phosphoryl amide. See Phosphoramide.
Phosphoryl chloride. See Phosphorus oxychloride.
Phthalandione. See Phthalic anhydride.
3-Picoline. See β-Picoline.
4-Picoline. See γ-Picoline.
Picramide. See Trinitroaniline.
Picraminic acid. See Picramic acid.
Picronitric acid. See Picric acid.
Picrotol. See Silver picrate.
Piece resin. See Rosin.
Pimelic ketone. See Cyclohexanone.
Pimenta. See Allspice.
α-Pinene. See Pinene.
1-Piperoylpiperidine. See Piperine.
Plattnerite. See Lead dioxide.
Plumbago. See Graphite.
Plumbous oxide. See Litharge.
Plumbous sulfide. See Lead sulfide.
Plumbum. See Lead.
Podophyllum resin. See Podophyllin.
Pogy oil. See Menhaden oil.
Poison oak. See Poison ivy.
Poison sumac. See Poison ivy.
Polydymite. See Nickelous, nickelic sulfide.
Polyethylene polysulfide. See "Omilite."
Polymercized acetaldehyde. See Metaldehyde.
Polyoxymethylene glycol. See Paraformaldehyde.
Potassamide. See Potassium amide.
Potassium acid oxalate. See Potassium binoxalate.
Potassium-aluminum sulfate. See Alum.
Potassium antimonyltartrate. See Antimony potassium tartrate.
Potassium-antimony oxalate. See Antimony potassium oxalate.
Potassium auribromide. See Gold-Potassium bromide.
Potassium aurichloride. See Gold-potassium chloride.
Potassium aurocyanide. See Gold-potassium cyanide.
Potassium bisulfide. See Potassium hydrosulfide; Potassium sulfhydrate.
Potassium bisulfite. See Potassium hydrogen sulfite.
Potassium cyanaurite. See Gold-potassium cyanide.

Potassium dihydrogen arsenate. See Potassium arsenate.
Potassium ethyl xanthate. See Potassium xanthate.
Potassium hydrate. See Potassium hydroxide.
Potassium hyperchlorate. See Potassium perchlorate.
Potassium mercuric iodide. See Potassium iodomercurate (II).
Potassium metabisulfite. See Potassium pyrosulfite.
Potassium oxyfluoniobate. See Potassium pentafluoniobate.
Potassium oxymuriate. See Potassium chlorate.
Potassium perosmate. See Potassium osmate.
Potassium peroxydisulfate. See Potassium persulfate.
Potassium rhodanide. See Potassium sulfocyanate.
Potassium sesquioxide. See Potassium trioxide.
Potassium-strontium chlorate. See Strontium-potassium chlorate.
Potassium sulfuret. See Potassium sulfide.
Potassium thiocarbonate. See Potassium sulfocarbonate.
Potassium thiocyanate. See Potassium sulfocyanate.
Potassium trinitroresorcinate. See Potassium styphnate.
Potassium-uranium nitrate. See Uranium-potassium nitrate.
Powder of algraoth. See Antimony chloride.
Procaine borate. See Borocaine.
1, 2-Propanediol. See Propylene glycol.
Propane nitrile. See Ethyl cyanide.
1, 2, 3-Propanetriol. See Glycerine.
Propanoic anhydride. See Propionic anhydride.
1-Propanol. See n-Propyl alcohol.
2-Propanol-1-N, N-dibutylamine. See Dibutyl isopropanolamine.
Propanone. See Acetone.
Propanoyl chloride. See Propionyl chloride.
Propenal. See Acrolein.
Propene. See Propylene.
Propene acid. See Acrylic acid.
Propene nitrile. See Acrylonitrile.
Propene oxide. See Propylene oxide.
1, 2, 2-Propenetricarboxylic acid. See Aconitic acid.
2-Propen-1-ol. See Allyl alcohol.
2-Propenylamine. See Allyl amine.
Propionamide nitrile. See Cyanoacetamide.
Propione. See Diethyl ketone.
Propionic ether. See Ethyl propionate.
Propionitrile. See Ethyl cyanide.
Propyl alcohol, secondary. See Isopropyl alcohol.
Propylene dichloride. See 1, 2-Dichloropropane.
Propylene glycol acetate. See Methyl glycol acetate.
Propylethylene. See Amylene; 1-Pentene.
Propylic aldehyde. See Propionaldehyde; Propyl aldehyde.
Propyl methanoate. See n-Propyl formate.
1-Propyl thiopropane. See Propyl sulfide.
Propyl-3, 4, 5-trihydroxybenzoate. See Propyl gallate.
Propyne. See Allylene; Methyl acetylene.
2-Propyn-1-ol. See Propargyl alcohol.
Proustite. See Silver thioarsenite.
Prussic acid. See Hydrocyanic acid.
Prussite. See Cyanogen.
Pseudo cotunnite. See Potassium lead chloride.
Purple foxglove. See Digitalis.
Purpureo. See Chloropentamminecobalt (III) chloride.
Pyrethrolone ester of chrysanthemum dicarboxylic acid monomethyl ester. See Pyrethrin II.
Pyrethrolone ester of chrysanthemum monocarboxylic acid. See Pyrethrin I.
β-Pyridyl-α-N-methylpyrrolidine. See Nicotine.
β-Pyridyl-α-pyrrolidine. See Nornicotine.
Pyroantimonate. See Potassium hydroxoantimonate.
Pyrocatechin. See Pyrocatechol.
Pyrochroite. See Manganous hydroxide.
Pyrogallic acid. See Pyrogallol.
Pyromucic acid. See Furoic acid.
Pyruvaldehyde. See Pyruvic aldehyde.
Quebrachine. See Yohimbine.
Quicklime. See Calcium oxide.
Quinacrine hydrochloride. See "Atabrine" hydrochloride.
Quinol. See p-Hydroquinone.
Quinone. See Benzoquinone.
Quinone monoxime. See p-Nitrosophenol.
RDX. See Cyclotrimethylene trinitramine.
R salt. See Sodium β-naphthol disulfonate.
Racemic acid. See Tartaric acid.
Radium emanation. See Radon.
Realgar. See Arsenic bisulfide.
Red lead. See Lead oxide.
Red oil (commercial grade). See Oleic acid.
Red phosphorus. See Phosphorus (amorphous, red).
Red potassium chromate. See Potassium bichromate.
Red potassium prussiate. See Potassium ferricyanide.
Red prussiate of potash. See Potassium ferricyanide.
Red prussiate of soda. See Sodium ferricyanide.
Red prussiate of sodium. See Sodium ferricyanide.
Redwood. See Brazil wood.
Resin, copal. See Copal.
Resorcin. See Resorcinol.
Resorcinol phthalein. See Fluorescein.
Retinol. See Rosin oil.
Ricinine. See 1, 2-Dihydro-4-methoxy-1-methyl-2-oxonicotino-nitrile.
Ricinus oil. See Castor oil.
Ridicine. See 1, 2-Dihydro-4-methoxy-1-methyl-2-oxonicotino-nitrile.
Rodinol. See p-Aminophenol.
Roman vitriol. See Copper sulfate.
Rosaniline dyes. See Triphenylmethane dyes.
Rosin. See Colophony, powder; Pine resin.
Rosin esters. See Ester gum.
Rubidium hydrate. See Rubidium hydroxide.
Rutile. See Titanium dioxide.
SNG. See Blasting gelatin.
Safety solvent. See Stoddard solvent; Varnoline.
Sal acetosella. See Potassium binoxalate.
Sal ammonia. See Ammonium chloride.
Salicylic aldehyde. See Salicyl aldehyde.
Salol. See Phenyl salicylate.
Salt. See Sodium chloride.
Salt of sorrell. See Potassium binoxalate.
Saltpeter. See Potassium nitrate.
Santonic lactone. See Santonin.
Sapoglycosides. See Saponins.
Sapotoxins. See Saponins.
Sarcosine. See N-Methylglycine.
"Saxin." See Saccharin.
Scacchite. See Manganese dichloride.
Schiff's base. See Disalicylal propylene diimine.
Scopolamine. See Hyoscine.
Scorodite. See Ferric arsenate.
Sea onion. See Squill, red.
Sea salt. See Sodium chloride.

Sellaite. See Magnesium fluoride.
Seneca oil. See Crude oil (petroleum).
Sequestrene. See Disodium ethylenediamine tetraacetate.
Sheele's mineral. See Copper arsenite.
Sheep dip. See Arsenical dip, liquid.
Shikimole. See Safrole.
Signal oil. See Mineral seal oil.
Silicic acid (precipitated). See Silica gel.
Silicic anhydride. See Silica.
Silicochloroform. See Trichlorosilane.
Silicoethane. See Disilane.
Silicofluoric acid. See Hydrofluosilicic acid.
Silicofluorides. See Fluosilicates.
Silicon dioxide. See Quartz; Silica.
Silicon hydride. See Silanes.
Silicon tetrachloride. See Silicon chloride.
Silver diaminodihydroxyarsenobenzene. See Silver arsphenamine.
Silver diarsenal. See Silver arsphenamine.
Silver orthoarsenite. See Silver arsenite.
Silver protein, mild. See "Argyrol."
Silver salvarsan. See Silver arsphenamine.
Silver sulfocarbolate. See Silver phenolsulfonate.
Slaked lime. See Calcium hydroxide.
Soda chlorate. See Sodium chlorate.
Sodamide. See Sodium amide.
Soda monohydrate. See Sodium carbonate.
Soda niter. See Sodium nitrate.
Sodium acetylarsanilate. See Arsacetin.
Sodium acid chromate. See Sodium dichromate.
Sodium acid sulfate. See Sodium bisulfate.
Sodium-aluminum sulfate. See Aluminum-sodium sulfate.
Sodium aminophenyl arsonate. See Sodium arsanilate.
Sodium anilinearsonate. See Sodium arsanilate.
Sodium o-arsenate. See Sodium arsenate.
Sodium arsphenolamine. See Sodium arsphenamine.
Sodium auribromide. See Gold-sodium bromide.
Sodium aurichloride. See Gold-sodium chloride.
Sodium aurocyanide. See Sodium cyanoaurite.
Sodium binoxide. See Sodium peroxide.
Sodium borate. See Sodium tetraborate.
Sodium diarsenol. See Sodium arsphenamine.
Sodium dimethyl arsenate. See Sodium cacodylate.
Sodium dioxide. See Sodium peroxide.
Sodium dithionite. See Sodium hydrosulfite.
Sodium hydrate. See Sodium hydroxide.
Sodium hydrogen sulfate. See Sodium bisulfate.
Sodium hydrogen sulfite. See Sodium bisulfite.
Sodium hyposulfite. See Sodium hydrosulfite.
Sodium N-methylamine acetate. See Sodium sarcosinate.
Sodium methylarsenate. See Sodium methanearsenate.
Sodium N-methyltaurine. See Sodium 2-(N-methylamino) ethane sulfonate.
Sodium monosulfide. See Sodium sulfide.
Sodium nitrophenate. See Sodium p-nitrophenoxide.
Sodium perborate tetrahydrate. See Sodium perborate.
Sodium N-phenylglycinamine-p-arsonate. See Tryparsamide.
Sodium o-phosphate, tertiary. See Trisodium phosphate.
Sodium rhodanate. See Sodium sulfocyanide.
Sodium rhodanide. See Sodium sulfocyanide.
Sodium sulfhydrate. See Sodium hydrosulfide.
Sodium sulfocyanate. See Sodium sulfocyanide.
Sodium sulfovinate. See Sodium ethylsulfate.
Sodium superoxide. See Sodium peroxide.
Sodium thiocyanate. See Sodium sulfocyanide.
Sodium m-uranate. See Sodium uranate.
Sodium xanthogenate. See Sodium ethylxanthate.
Soup. See Nitroglycerin.
Soya bean oil. See Soybean oil.
Spanish fly. See Cantharides.
Sperrylite. See Platinum arsenide.
Sphaerocobaltite. See Cobaltous carbonate.
Spirit glyceryl trinitrate. See Spirits of nitroglycerin.
Spirit of Hartshorn. See Aromatic spirits of ammonia.
Spirit of turpentine. See Turpentine oil.
Spirit of wine. See Ethyl alcohol.
Stagger weed. See Delphinium.
Stannane. See Tin tetrahydride.
Stannic oxide (cassiterite). See Tin oxide.
Stannic phosphide. See Tin monophosphide.
Stannous fluoride. See Tin fluoride.
Stannous oxide. See Tin oxide.
Starch nitrate. See Nitrostarch.
Steatite. See Soapstone dust; Talc.
Stibenyl. See Sodium p-acetylaminophenylantimoniate.
Stibine. See Antimony hydride; Hydrogen antimonide.
Stibium. See Antimony.
Stilbestrol. See Diethylstilbestrol.
Stoddard solvent. See Cleaning solvents (kerosene class); Naphtha, safety solvent.
Strontium o-arsenite. See Strontium arsenite.
Strontium diuranate. See Uranium strontium oxide.
Strophanthin K. See Strophanthin.
"Stypticin." See Cotarnine chloride.
Styralyl alcohol. See Phenyl methyl carbinol.
Styrene dibromide. See 1, 2-Dibromoethyl benzene.
Styrene monomer. See Phenylethylene.
Suberane. See Cycloheptane.
Subgallate. See Bismuth gallate, basic.
Subsalicylate. See Bismuth salicylate, basic.
Succinchlorimide. See N-Chlorosuccinimide.
Succinic acid anhydride. See Succinic anhydride.
Sugar of lead. See Lead acetate.
Sulfanilic acid diazide. See p-Diazobenzenesulfonic acid.
Sulfocarbolic acid. See Phenosulfonic acid.
Sulfonated castor oil. See Turkey red oil.
Sulfonyl chloride. See Sulfuryl chloride.
Sulfuretted hydrogen. See Hydrogen sulfide.
Sulfur flour. See Sulfur.
Sulfuric chloride. See Sulfuryl chloride.
Sulfuric chlorohydrin. See Chlorosulfonic acid.
Sulfuric ether. See Ethyl ether.
Sulfuric oxychloride. See Sulfuryl chloride.
Sulfur monobromide. See Sulfur bromide.
Sulfur monochloride. See Sulfur chloride.
Sulfur monofluoride. See Sulfur fluoride.
Sulfurous acid, anhydride. See Sulfur dioxide.
Sulfurous oxychloride. See Thionyl chloride.
Sulfuryl amide. See Sulfamide.
Superpalite. See Trichloroacetyl chloride.
Sweet oil. See Olive oil.
Sylvic acid. See Abietic acid.
2, 4, 5-T. See 2, 4, 5-Trichlorophenoxy acetic acid.
TDE. See 1, 1-Dichloro-2, 2-bis (p-chlorophenyl) ethane.
"TG-9." See Triethylene glycol dipelargonate.
TNA. See Tetranitroaniline.
TNT. See Trinitrotoluene.
TNX. See 2, 4, 6-Trinitroxylene.
TSN. See Tetramethylsuccinonitrile.
TSPP. See Tetrasodium pyrophosphate.
Tabasco pepper, tincture of. See Capsicum.
Talc dust. See Soapstone dust.
Talcum. See Talc.
Tallol. See Tall oil.
Tannin. See Tannic acid.
Tarapacaite. See Potassium chromate.

Tar camphor. See Naphthalene.
Tar oil, rectified. See Pine tar oil.
Tartar emetic. See Antimony-potassium tartrate; Potassium-antimony tartrate.
Tetraboron decahydride. See Dihydrotetraborane.
Tetrabromoethane. See Acetylene tetrabromide.
Tetrabromoethylene. See Dicarbontetrabromide.
Tetrabromomethane. See Carbon tetrabromide.
Tetrabromosilane. See Silicon tetrabromide.
Tetrabromosilicane. See Silicon bromide.
Tetrachlorodiphenylethane. See 1,1-Dichloro-2,2-bis (p-chlorophenyl) ethane.
Tetrachloroethane-1,1,2,2. See Acetylene tetrachloride.
Tetrachloroethylene. See Perchloroethylene.
Tetrachloromethane. See Carbon tetrachloride.
1,2,3,4-Tetrachloro-1,2,3,4-tetrahydronaphthalene. See Tetrachloronaphthalene.
Tetracobalt dodecacarbonyl. See Cobalt carbonyl.
Tetradecyl alcohol. See Tetradecanol.
α-Tetradecylene. See 1-Tetradecene.
Tetradymite. See Bismuth tritelluride.
Tetraethyl diarsine. See Arsenic diethyl.
Tetraethylene. See Cyclobutane.
Tetraethyl-o-silicate. See Ethyl silicate.
Tetraethylthiuriam disulfide. See Bis(diethylthiocarbamyl) disulfide.
Tetrafluoromethane. See Carbon tetrafluoride.
Tetrafluorosilane. See Silicon tetrafluoride.
1,2,3,4-Tetrahydrobenzene. See Cyclohexene.
Tetrahydromethylfuran. See 2-Methyl tetrahydrofuran.
Tetrahydro-1,4-oxazine, See Morpholine.
Tetrahydrosylvan. See 2-Methyl tetrahydrofuran.
Tetraiodomethane. See Carbon tetraiodide.
Tetraiododisilane-ethylene. See Disilicon tetraiodide.
Tetraiodosilane. See Silicon tetraiodide.
Tetralite. See Tetryl.
Tetramethyldiarsine. See Cacodyl.
Tetramethyl diarsyl. See Arsenic dimethyl.
Tetramethylene. See Cyclobutane.
Tetramethylene cyanide. See Adiponitrile.
Tetramethylstannane. See Tin tetramethyl.
Tetramethylthiuram disulfide. See Bis(dimethylthiocarbamyl) disulfide.
Tetraphosphorus hexasulfide. See Phosphorus trisulfide.
Thallium hydrogen sulfate. See Thallous hydrogen sulfate.
Thallium monoiodide. See Thallium iodide.
Thallium monosulfide. See Thallium sulfide.
Thallium oxide. See Thallium monoxide.
Thallous acetate. See Thallium acetate.
Thallous bromide. See Thallium bromide.
Thallous chlorate. See Thallium chlorate.
Thallous chloride. See Thallium chloride.
Thallous cyanide. See Thallium cyanide.
Thallous dichromate. See Thallium dichromate.
Thallous dithionate. See Thallium dithionate.
Thallous fluoride. See Thallium monofluoride.
Thallous hydroxide. See Thallium hydroxide.
Thallous nitrate. See Thallium nitrate.
Thallous oleate. See Thallium oleate.
Thallous oxalate. See Thallium oxalate.
Thallous oxide. See Thallium monoxide.
Thallous perchlorate. See Thallium perchlorate.
Thallous phenoxide. See Thallium phenoxide.
Thallous o-phosphate. See Thallium o-phosphate.
Thallous selenate. See Thallium selenate.
Thallous selenide. See Thallium selenide.
Thallous-silver nitrate. See Thallium-silver nitrate.
Thallous stearate. See Thallium stearate.
Thallous sulfate. See Thallium sulfate.
Thallous sulfide. See Thallium sulfide.
Thallous sulfite. See Thallium sulfite.
Thallous m-tellurate. See Thallium m-tellurate.
Thallous thiocyanate. See Thallium thiocyanate.
Theine. See Caffeine.
Theobromine lithium. See Theobromose.
Theobromine-sodium formate. See "Theophorin."
Thiacetic acid. See Thioacetic acid.
Thiirane. See Ethylene sulfide.
2,2-Thiobis(4,6-dichlorophenol). See Bithionol.
Thiocarbamide. See Thiourea.
Thiocarbanil. See Phenyl mustard oil.
Thiodiglycol. See Thiodiethylene glycol.
Thiodiphenylamine. See Phenothiazine.
Thioethyl ether. See Ethyl sulfide.
Thiofuran. See Thiophene.
2-Thio-4-keto-thiazolidine. See Rhodanine.
Thiophenol. See Phenyl mercaptan.
Thiophosgene. See Thiocarbonyl chloride.
2,4-Thioxene. See p-Thioxene.
Thyme camphor. See Thymol.
Tiemannite. See Mercuric selenide.
Tiglium oil. See Croton oil.
Tin bifluoride. See Tin fluoride.
Tin bromide. See Stannic bromide.
Tincal. See Borax.
Tin chloride. See Stannic chloride.
Tinkal. See Borax.
Tin phosphide. See Tin monophosphide.
Tin tetrabromide. See Stannic bromide.
Titanium butylate. See Butyl titanate.
Titanium isopropylate. See Isopropyl titanate.
Tobacco wood. See Witch hazel.
Tochlorine. See Sodium p-toluenesulfonchloramine.
Tolamine. See Sodium p-toluenesulfonchloramine.
Toluene diisocyanate. See Tolylene diisocyanate.
α-Toluene thiol. See Benzyl mercaptan.
Toluene trichloride. See Benzotrichloride.
α-Toluic acid. See Phenylacetic acid.
p-Toluidine hydrochloride. See Chlorotoluidine.
Toluol. See Toluene.
p-Tolylacetamide. See p-Acetotoluidine.
Tolylenediamine. See 2,4-Toluenediamine.
o-Tolyl phosphate. See Tricresyl phosphate.
Toxalbumin. See Abrin.
Toxilic acid. See Maleic acid.
Toxilic anhydride. See Maleic anhydride.
Transil oil. See Transformer oil.
Triacetin. See Glyceryl triacetate.
2,4,6-Triamino-sym-triazine. See Melamine.
sym-Triazinetriol. See N-Cyanuric acid.
Triazobenzene. See Phenyl azoimide; Diazobenzolimide.
Tribromomethane. See Bromoform.
Tribromonitromethane. See Bromopicrin.
Tributyl citrate. See Butyl citrate.
Tricalcium o-arsenate. See Calcium arsenate.
Tricalcium phosphate. See Calcium phosphate, tribasic.
Trichloracetaldehyde. See Chloral.
Trichloroacetic aldehyde, hydrated. See Chloral hydrate.
sym-Trichlorobenzene. See 1,3,5-Trichlorobenzene.
uns-Trichlorobenzene. See 1,2,4-Trichlorobenzene.
1,1,1-Trichloro-2-bis(p-chlorophenyl) ethane. See DDT.

Trichlorocyanidine. See Cyanuric chloride.
1, 1, 1-Trichloroethane. See α-Trichloroethane.
1, 1, 2-Trichloroethane. See β-Trichloroethane.
Trichloromethane. See Chloroform.
Trichloromethane sulfonyl chloride. See Perchloromethyl mercaptan.
Trichloromethylchloroformate. See Diphosgene.
Trichloro-sym-triazine. See Cyanuric chloride.
Tricresol. See Cresol.
Tricyanic acid. See N-Cyanuric acid.
Tricyanogen chloride. See Cyanuric chloride.
Trideuterio ammonia. See Ammonia-d$_3$.
Triethoxyboron. See Ethyl borate.
Triethoxymethane. See Triethyl o-formate.
Triethyl aluminum. See Aluminum triethyl.
Triethyl borine. See Boron triethyl.
Triethylene glycol methyl ether acetate. See Methoxytriglycol acetate.
Tri(7-ethyl-2-methyl-4-undecyl) borate. See Tritetradecylborate.
Trifluoromethane. See Fluoroform.
Trifluoromethylbenzene. See Benzotrifluoride.
Trihydroxybenzene. See Pyrogallol.
Trimethoxy borine. See Methyl borate.
Trimethyl aluminum. See Aluminum methyl.
Trimethylaminomethane. See tert-Butylamine.
Trimethyl borate. See Methyl borate.
Trimethyl borine. See Boron trimethyl.
Trimethyl cyclohexanol. See 3, 3, 5-Trimethyl cyclohexanol-1.
Trimethylene. See Cyclopropane.
Trimethylene chloride. See 1, 3-Dichloropropane.
Trimethyl methane. See Isobutane.
2, 2, 4-Trimethyl pentane. See Isooctane.
α, α, α-Trimethyl trimethylene glycol. See 2-Methyl-2, 4-pentanediol.
2, 46-Trimethyl-1, 3, 5-trioxane. See Paraldehyde.
Trinitrophenol. See Picric acid.
Trinitrophenylmethylnitramine. See Tetryl.
Trinitrophloroglucinol. See Trinitrophloroglucine.
2, 4, 6-Trinitroresorcinol. See Styphnic acid.
sym-Trinitrotoluol. See Trinitrotoluene.
Trioxymethylene. See Trioxane.
Triphosgene. See Hexachloromethylcarbonate.
Tripropyl aluminum. See Aluminum tripropyl.
Tripropyl borate. See Propyl borate.
Trisilicon octahydride. See Trisilane.
"Triton." See Trinitrotoluene.
Troilite. See Ferrous sulfide.
Tropinecarboxylic acid. See Ecgonine.
Tubatoxin. See Rotenone.
β, β-Tubatoxythiocyanodiethyl ether. See "Lethane 384."
Tungsten oxytetrachloride. See Tungsten oxychloride.
Turpentine substitute. See Mineral Spirits No. 10.
UX$_2$. See Protactinium.
Unslaked lime. See Calcium oxide.
Uranium-ammonium chloride. See Uranium oxyammonium chloride.
Uranium diboride. See Uranium boride.
Uranium X$_2$. See Protactinium.
Uranyl acetate. See Uranium oxyacetate.
Uranyl-ammonium carbonate. See Uranium oxyammonium carbonate.
Uranyl benzoate. See Uranium oxybenzoate.
Uranyl bromide. See Uranium oxybromide.
Uranyl chloride. See Uranium oxychloride.
Uranyl formate. See Uranium oxyformate.
Uranyl iodate. See Uranium oxyiodate.
Uranyl iodide. See Uranium oxyiodide.
Uranyl monohydrogen phosphate. See Uranium oxymonohydrogen phosphate.
Uranyl nitrate. See Uranium oxynitrate.
Uranyl oxalate. See Uranium oxyoxalate.
Uranyl oxide. See Uranium trioxide.
Uranyl perchlorate. See Uranium oxyperchlorate.
Uranyl phosphate. See Uranium phosphate.
mono-Uranyl-o-phosphate. See Uranium phosphate.
Uranyl-potassium nitrate. See Uranium-potassium nitrate.
Uranyl sulfate. See Uranium oxysulfate.
Uranyl sulfide. See Uranium oxysulfide.
Uranyl sulfite. See Uranium oxysulfite.
Urea crystal. See Carbamide.
Urea hydrogen peroxide. See Urea peroxide.
α-Ureido-isobutyric acid lactam. See Dimethyl hydantoin.
Urethane. See Ethyl carbamate.
Uric oxide. See Uric acid.
"Urotropin." See Hexamethylenetetramine.
Uroxin. See Alloxantin.
Ursol. See. p-Phenylenediamine.
"Ursol" P. See p-Aminophenol.
V. M. & P. See "Dryolene."
Valeryl diethylamide. See Valyl.
Vanadic sulfate. See Vanadyl sulfate.
Vanadium dioxide. See Vanadium tetraoxide.
Vanadium oxide. See Vanadium monoxide.
Vanadium sulfate. See Vanadyl sulfate.
Vanadium trioxide. See Vanadium sesquioxide.
Vanadium trisulfide. See Vanadium sesquisulfide.
Vanadous chloride. See Vanadium dichloride.
Vanadyl chloride. See Vanadium oxydichloride.
Varnolene. See Cleaning solvents (kerosene class).
"Varsol." See Cleaning solvents (kerosene class).
Verdigris, blue or green. See Copper acetate, basic.
Vermillion. See Mercuric sulfide, red.
Vienna green. See Copper acetoarsenite.
Villiaumite. See Sodium fluoride.
Vinegar acid. See Acetic acid.
Vinol. See Vinyl alcohol.
Vinylacetonitrile. See Allyl cyanide.
Vinylbenzene. See Phenyl ethylene; Styrene (monomer).
Vinyl cyanide. See Acrylonitrile.
Vinylethylene oxide. See Butadiene monoxide.
Vinylstyrene. See m-Divinyl benzene.
Vinyl trichloride. See β-Trichloroethane.
Visha. See Aconitum ferox.
Water glass. See Sodium silicate.
Water of ammonia. See Ammonia hydroxide.
White arsenic. See Arsenic trioxide.
White caustic. See Sodium hydroxide.
White lead. See Lead carbonate, basic.
White precipitate. See Mercury, ammoniated.
White spirit. See Mineral Spirits No. 10; Turpentine substitutes.
White spirits. See Naphtha, safety solvent.
White tar. See Naphthalene.
Wolfram. See Tungsten.
Wolfsbane. See Aconite; Arnica.
Wood dust. See Sawdust.
Wood vinegar. See Pyroligneous acid.
Wool grease. See Lanolin.
Wormwood. See Absinthium.
Wulfenite. See Lead molybdate.
Wurtzite. See Zinc sulfide(α).
p-Xenylamine. See p-Aminodiphenyl.
Xylidine. See N, N-Dimethylaniline.
m-Xylol. See m-Xylene.
o-Xylol. See o-Xylene.
p-Xylol. See p-Xylene.
Yellow jasmine. See Gelsemium sempervirens.

Yellow prussiate of potash. See Potassium ferrocyanide.
Yellow prussiate of soda. See Sodium ferrocyanide.
Yellow resin. See Pine resin.
Yttria. See Yttrium oxide.
ZMA. See Zinc m-arsenite.
Zinc arsenite. See Zinc m-arsenite.
Zinc ethyl. See Zinc diethyl.
Zincite. See Zinc oxide.
Zinc white. See Zinc oxide.
Zingiber. See Ginger.
Zinkosite. See Zinc sulfate.
Ziram. See Zinc dimethyldithiocarbamate.

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